Knowledge & Scientific News

A MONTHLY JOURNAL OF SCIENCE.

Conducted by MAJOR B. BADEN-POWELL, F.R.A.S., and E. S. GREW, M.A.

VOL. III. No. 21. [NEW SERIES.] AUGUST, 1906. [Entered at Stationers' Hall.] SIXPENCE NET.

CONTENTS—See page V.

Cloud Photography.

By WILLIAM J. S. LOCKYER, M.A., Ph.D., F.R.A.S.

WHO has not sat on the grass or a bench on a hot summer's afternoon and turned his head skywards and watched the ever-restless clouds wafted along by the aërial currents?

Who, also, has not had his attention drawn to a towering cumulus cloud mounting up and up into the higher regions of the atmosphere and preparing itself for a possible exhibition of atmospheric electricity, in the form of a thunderstorm?

Latent energy, grace, beauty, to say nothing of the exquisite gradations of shade, are all present in those masses of water-vapour or ice-crystals, and it is really surprising what little attention they receive, even at the hands of the photographer, except possibly for an occasional casual remark.

To the meteorologist of to-day the study of clouds has assumed an important part of his work, for by their movements and changes of form, the inner workings of the upper air currents can be, to a certain extent, watched. This must be so for a long time to come, as the employment of kites and *ballon-sondes* does not yet allow us to reach at short notice such elevated regions; clouds are therefore the only means we have for nearly continuous observation at great altitudes.

The part played by the photographer is to record, for later study if necessary, the forms and types of cloud The camera thus affords the means of making a classification of clouds more complete than was previously the case, in addition to presenting us with a most interesting pastime.

One decided advantage of cloud photography over many other photographic pieces of work, is that it can be pursued wherever the photographer happens to be. Clouds we have nearly always with us, and sometimes we think much too often, and the upper storey or roof of a house, failing a better position, affords an excellent place to work from.

One of the first cloud classifications was put forward by Luke Howard in 1803, and up to quite recently this has held first place. Many other attempts in the meantime have been made at a more scientific classification, and most, if not all of them, with the exception of that of Clement Ley, were simply makeshifts. Ley's classification is undoubtedly long, and is not well fitted for use except by professional investigators or those amateurs who wish to take up the subject of nephology thoroughly, and have plenty of time at their disposal. During more recent years, an attempt has been made to draw up a more simple and efficient system and that which is now being adopted is termed the "International System of Cloud Nomenclature."

There is, however, quite a large literature on cloud classification and cloud photography, but it is not my intention to pass this in review in this article. It may, however, serve a useful purpose to draw the reader's attention to several publications on this subject, if he should wish to dip more deeply into this interesting study.

The "International Cloud Atlas," to which reference has just been made, has text in English, French, and German, and is published by Gauthier Villars, in Paris (1896). The Hydrographic Office at Washington has published (1897) an atlas illustrative of cloud forms which includes 16 coloured plates.

Quite recently, Mr. A. W. Clayden has published a valuable contribution in his book on "Cloud Studies" (John Murray, London, 1905), and this contains a great number of photographic reproductions from his negatives.

In this Journal numerous illustrated articles have appeared from time to time on the progress of cloud photography. Thus, for instance, E. M. Antoniadi (Vol. XIV., p. 202 and Vol. XV., pp. 79 and 107); James Quicke (Vol. XIV., p. 103); Wilson Barker (Vol. XVII., p. 104); and H. C. Russell (August, 1894), have all contributed much information, which should be consulted by the photographer.

Other valuable contributions to cloud literature include "Instructions for Observing Clouds," by the Hon. Ralph Abercromby (London, 1888); "The Cloud World" (Elliot Stock, London, 1903), by Samuel Barker; "La Photographie el l'étude des Nuages" (Mendel, Paris, 1898), by Jacques Bayer; and several works and articles by Hildebrandson, Köppen, Newmeyer, Clement Ley, Angot, Tisserenc de Bord, Flammarion, &c.

The above references will, no doubt, serve to draw the reader's attention to some of the work that has been accomplished, and he will soon be able to extend this list for himself when he becomes better acquainted with the subject.

For the purpose of this article, only the two main classes into which clouds may be divided need be mentioned. The first is the "cumulus" form of cloud, which is formed by *vertical* convection, that is, the air is transported from one level to another. The second main class is the "stratus" cloud, which is generally the result of the flowing of two currents of air over each other, the temperatures being different in the adjacent layers.

The former type indicates an attempt to restore

XUM

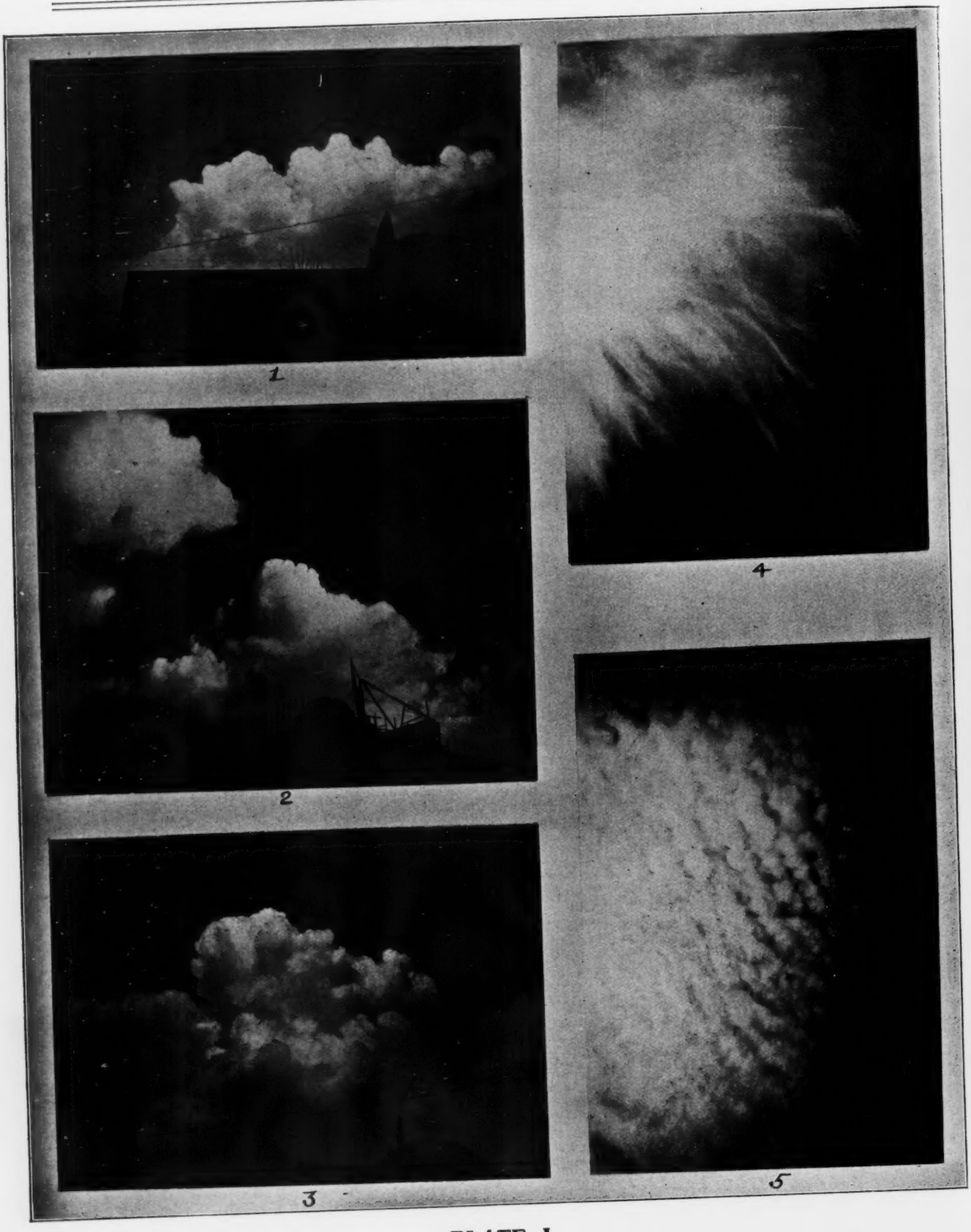


PLATE I.

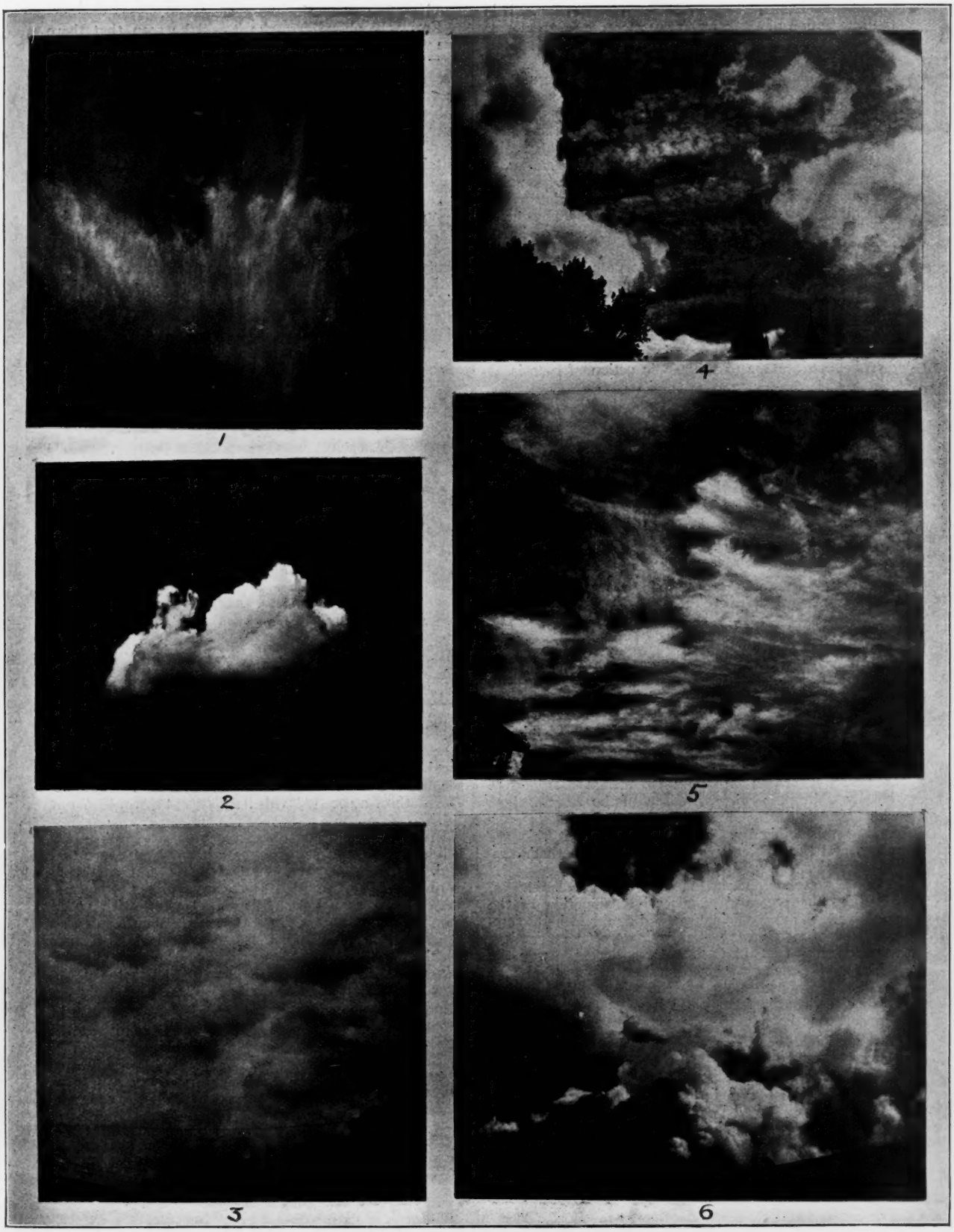


PLATE II.

XUM

equilibrium in the vertical direction, while the latter shows a similar effort in the horizontal direction. It is the interaction of these primary processes in greater or less degree which is responsible for the several intermediate types of clouds.

The existence of cloud at any elevation tells us that the atmosphere in that particular part is in a state of saturation, and that the vapour is being condensed. The form of the cloud also indicates to us the conditions under which this air space became saturated with the consequent formation of cloud, and hence shows, to some extent, changes which are in progress in the upper air which may affect the weather at the earth's surface. The direction of motion of the cloud finally gives us a good clue to the winds which are blowing high up in the air.

While the eye can be devoted to note the direction, the camera should be employed to record the form.

In cloud photography, the great desideratum is to produce contrast and secure clear, well-defined negatives with brilliant high lights. The predominance of blue rays in reflected skylight is in many cases a great drawback, since the photographic action of blue is almost identical with that of white light. It becomes therefore, almost a necessity to quench the blue of the sky while preserving the light of the clouds. The whole art of successful cloud photography lies in overcoming this difficulty. The ways of doing this are many, and the efficiency of the different methods employed varies to a great degree.

One of these methods includes the use of a diaphragm, a quick exposure, and an after intensification of the negative. A more efficient method seems to be the employment of a coloured screen in front of the objective, the exposure of the plate necessarily depending on the colour and density of the glass or liquid employed. In fact, there are many variables involved, not forgetting the speed of the plate itself. Even when the exposure has been made the question of development arises. Some, in fact most, authorities advise a fairly weak solution with a slow methodical development.

Many workers prefer to rely on backed slow plates, a full exposure and a properly restrained developer. Mr. Clayden, to whom reference has above been made, photographs his clouds by reflection from a black mirror placed just in front of his object glass; he employs slow plates, namely, photo-mechanical, and by this process he obtains results which, as he says, are "uniformly and continuously successful."

From the above remarks it will be seen that there are many ways and means of photographing clouds, and very much depends on the operator.

My own experience of the subject is very limited, in fact, my attention was only attracted specially to the subject during April of the present year. I may, however, preface the following description of the method I employ by saying that my object was not necessarily to obtain pictorial photographs, but negatives which would bring out well the forms and changes of both dense and very thin clouds. In fact, I have not yet gone to the length of using a wide angle lens, so necessary for including a large field, as my intention up to the present has been to try and secure satisfactory photographs. The photographs which accompany this article will serve to show some examples of various kinds of clouds, which are representatives of types of photographs, all of which are obtained without any difficulty. The camera which I use (see Fig. 1) is a small 5 by 4 instrument, made by Winkel, of Gottingen, Germany, and is fitted with a Zeiss lens of 4.4 inches focal length, and 0.75 inches aperture. I usually work the diaphragm shutter, giving an exposure of about one-twentieth of a second, with the lens cut down to about *f* 8.

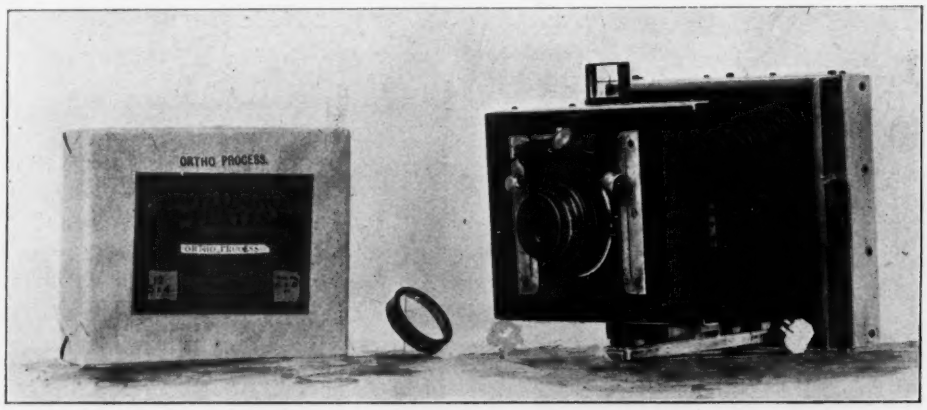


Fig. 1.—Cloud Photographic Equipment.

Fixed on the front of the lens is a Kodak glass yellow screen, which increases a normal exposure tenfold. Although I have not used many different kinds of plates, I find that the ortho-process plates of Messrs. Wellington and Ward (Elstree, Herts), with speed number H and D 80, give very satisfactory results, so satisfactory, in fact, that I have not looked further afield.

Regarding development, I am no advocate of the slow process, and prefer the negative to be fully developed in about five minutes. The actual solutions I employ are given below, and equal quantities of each are used; sometimes three or four plates are developed with the same five ounces of developer.

HYDROQUINONE DEVELOPER (MAWSON).

No. 1 SOLUTION.

Hydroquinone	320 grs.
Bromide of Potassium	320 ,,
Metabisulphite of Soda	320 ,,
Water (distilled)	80 ozs.

No. 2 SOLUTION.

Caustic Soda	600 grs.
Water (distilled)	80 ozs.

The camera is always held in the hand, and pointed in a direction which, as a rule, is well away from that of the sun.

If the reader examines the two plates of photographs he will see that good details are given both in the heavy cumuli (Plate 1., Figs. 1, 2, and 3), and in the light, fleecy clouds (Plate 1, Figs. 4 and 5, and Plate 2, Figs. 1, 4, and 5). It may be considered that the contrast between the blue sky and cloud, in some of the illustrations, such as Plate 1, Fig. 2, is too strong; from a pictorial point of view, this is possibly true, but from the cloud-form standpoint, I do not think it is excessive.

Very interesting is the photograph in Plate 2, Fig. 5 On the occasion on which this plate was exposed, there were cross currents in the upper air, and the apparent mingling of the clouds formed a striking object. In the same plate (Fig. 3) the photograph illustrates an overcast sky, with low clouds travelling quickly from north-east. Fig. 1, also in Plate 2, is a good illustration of clouds being drawn out by the action of a faster moving current of air. The form known as "mare's tails," is well shown in Plate 1, Fig. 4, while Fig. 5 of the same plate, is typical of "mackerel sky."

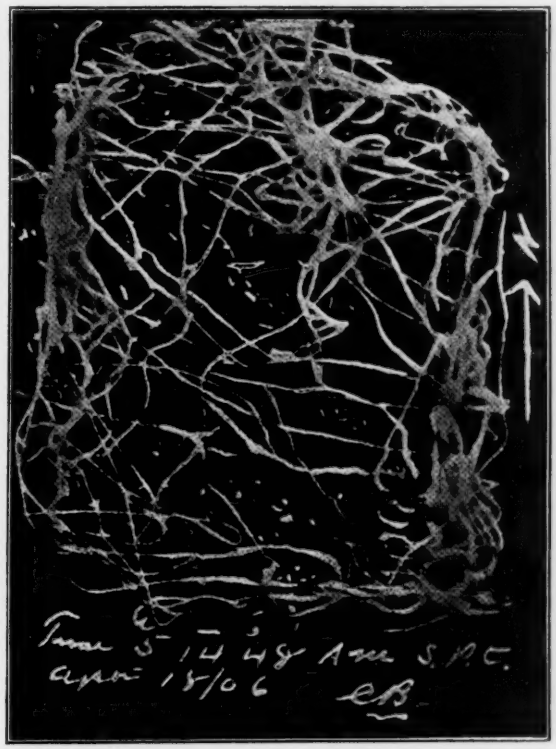
Most of these photographs were secured during spare moments, generally between 1 and 2 o'clock, p.m., so that the best positions or conditions of the clouds could not always be chosen. The fact also that they were taken at South Kensington indicates further that the London photographer need not necessarily go far afield to find his subjects.

The Dipping Refractometer.

WE have received from Messrs. Carl Zeiss a description of their latest form of dipping refractometer, together with a bibliography of papers in scientific literature dealing with the subject. The dividing line between physics and chemistry is being gradually broken down, and we are beginning to trace a relationship between chemical constitution and physical characteristics. The determination of many physical data has become of recognised value in chemical analysis, and this is notably the case with the refractive index, which is of considerable use as a rapid sorting test, especially in the analysis of oils and fats. The firm of Zeiss has made a special instrument, known as the butyro-refractometer, for this purpose, and this is in common use in laboratories all over the world. The dipping refractometer, which is intended for the examination of liquids in general, is not so well known, though in many instances it will give immediate results as accurate as those given by chemical methods. The prism and plate are formed from one piece of glass, which is to be immersed in the given liquid, and the degree of the refraction of the light can then be read on the scale by means of the telescope. The refraction is proportional to the amount of the substance in the solution, and it is thus possible, with the aid of special tables, to make rapid determinations of, say, the amount of alcohol in spirit, albumen in blood serum, sugar in extracts, or to determine the strength of solutions of various salts in water.

The San Francisco Earthquake.

A COMMISSION to consider the Californian earthquake was appointed three days after its occurrence, and with the same American promptness has already presented its preliminary report. From it we gather that the area of destructive effects extended over four hundred and fifty square miles of territory, and was distributed on either side of a great rift extending for a distance of some hundred and eighty-five miles. Along the hundred and eighty-five miles of this rift, where movement has actually been observed, the displacement has been chiefly horizontal, and the country S.W. of the rift has moved to the N.W. relatively to the country on the other side of the rift. The amount of dislocation varies in the neighbourhood of the rift. Sometimes it is not more than six feet, sometimes as much as sixteen feet; eight or ten feet is the average. There was also a slight vertical movement amounting in some places along the rift



Signature of the San Francisco Earthquake,
Written by means of the seismograph at Oakland, California.

to four feet. It is the great length of the rift which makes the earthquake unique. Within the area of destructive effects the intensity varied greatly. It was greatest on the rift line. Water-pipes, conduits, and bridges crossing the line were rent asunder; trees were uprooted and cast to the ground in great numbers, and others were split from the roots up; some were snapped off short. Buildings were usually wrecked, but some escaped with slight damage. Fissures opened in the earth and closed again, and in one case a cow was engulfed. The places which suffered most, like San José, Stanford University (seven miles from the rift), are those which are underlain to a great extent by loose geological formations. It is suggested that the origin of disturbance lay at a considerable depth. A curious fact mentioned, however, by a correspondent of the *Scientific American* is that in the Almadan quicksilver mines of San José, 1,500 feet deep, the workmen did not feel the shock, though the buildings at the mouth of the mine were shaken down.

XUM

The New Asteroid 1906 TG.

By DR. GIORGIO ABETTI.

AMONGST the numerous asteroids which the photographic researches of Prof. Max Wolf and his co-workers at the Königstuhl Observatory, Heidelberg, are continually adding to the long list of those already discovered, there is a faint one of the 13th magnitude which, by reason of its very small diurnal orbital motion of about $\mu = 300''$, or nearly that of Jupiter* himself, is of particular interest to astronomers.

The new asteroid, provisionally known as 1906 TG, has, as seen from the earth, a slow retrograde motion—as is usually the case with asteroids when discovered near their opposition to the earth—parallel to, and a little south of, the ecliptic, which has given rise to the conjecture that of all the bodies of this class hitherto known this may be found to be the most distant. It was photographed anew at Königstuhl on March 3, and two days later it was observed visually at Vienna by Prof. Palisa, who followed it until April 22, when it had fallen to the 14.5 magnitude and changed from retrograde to direct motion.

Basing his data on the two first observations, viz., February 22 and March 5, Prof. Berberich was enabled to calculate an approximate *circular* orbit which at once revealed the small value of μ, or, in other words, the great distance of the asteroid from the sun. According to this first calculation the period of revolution came out as 11.37 years, which, in comparison with the 11.86 year period of Jupiter, was thus seen to be only half a year shorter; but as further observations became available, Prof. Berberich succeeded in deducing the following elliptic orbit :—

Epoch 1906, February 22·5 Berlin M.T.

M	=	48°	57′	23·″6	
ω	=	120	25	50·0	1906·0
Ω	=	315	34	6·8	
ι	=	10	20	53·0	
φ	=	9	38	42·6	
μ	=			295·″133	
log. a	=			0·719993	

This orbit must obviously not be taken as final, for of the entire path of 360°, but one sixtieth, corresponding to the observed motion through 6° in two months, has so far been observed.

In this second calculation the period of revolution, as given by $\mu = 295''.133$, comes out as 12.03 years, or almost two months greater than that of Jupiter, and it is evident that, when still further and more accurate orbital elements deduced from later observations have become available, the period of revolution may be found to be equal or even slightly less than that of Jupiter.

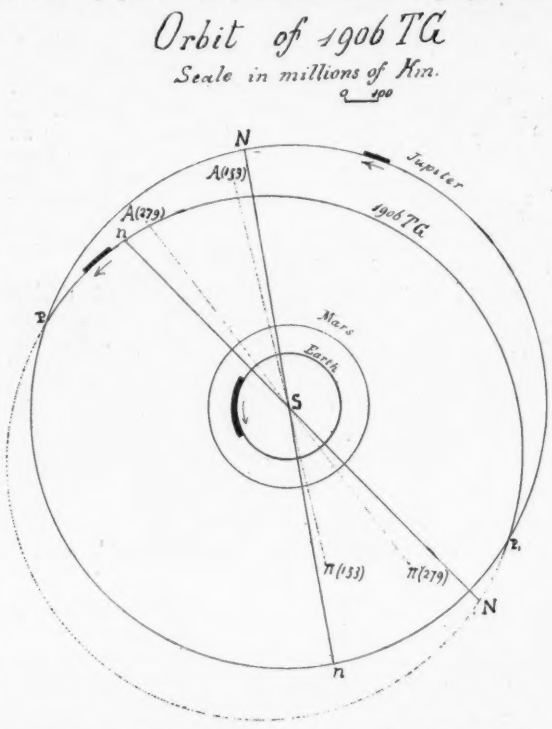
In any case the fact is now placed beyond dispute that there is a great resemblance in the revolutionary periods of the two bodies, or, if it is preferred, in their mean distances from the sun; for that of Jupiter is 5.20 r, or 5.20 times the radius of the earth's orbit, while that of TG (corresponding to log. $a = 0.72$) is 5.25 r.

* The diurnal orbital motions of the major planets are :

Planet.	μ, or diurnal orbital motion.		
Mercury	1473″	=	245·′5
Venus	576″	=	96·′1
Earth	354″	=	59·′1
Mars	188″	=	31·′5
Jupiter	299″	=	5·′0
Saturn	120″	=	2·′0

Now the distance of Jupiter, which has only a slightly eccentric orbit, is subject to but a small variation; the distance of TG, however, oscillates between 4.37 and 6.13, and as r, the radius of the earth's orbit, is equal to 150 million kilometres, it follows that the distance of the new asteroid from the sun can vary between 655 and 920 millions of kilometres. Its orbital eccentricity, moreover, is four times that of Jupiter, so that, bearing in mind the fact that the sun occupies one and the same focus in all the planetary orbits (all more or less elliptical), TG in each revolution about the sun pursues a path which is for about 5 years *within* and for about 7 years *without* the orbit of Jupiter.

If, as in the figure, we describe circles about a centre S, representing the sun, a better idea will be obtained of the orbit of the new asteroid with respect to the orbits of Jupiter, Mars, and the Earth, all projected on



the plane of the latter, *i.e.*, the plane of the ecliptic. The portions of TG's orbit lying outside and inside the path of Jupiter are indicated by dotted and continuous lines, while the points N and n represent the ascending and descending nodes respectively of the orbits of Jupiter and TG on the ecliptic. From February 22 to April 22, 1906, the three bodies, Jupiter, TG, and the Earth, had described the paths indicated by the short, heavy lines. At the present time, TG is moving faster than Jupiter, and, while continuing to recede from him, will shortly pass a point P, which, in the figure, represents the inter-section of the orbits as seen projected upon the ecliptic.

Taking the small difference in the sidereal revolutions of the two planets for granted, it is easy to see that an actual approach of the two bodies could only take place in the course of centuries; indeed, from a recent observation made by Prof. Palisa on May 22, it would appear that the mean diurnal motion given above is somewhat too small. A larger value would have made the resemblance between the sidereal revolutions still

greater. For the present, however, and for a considerable time to come, the great attractive force of Jupiter will be unable to alter in any essential particular the present path of TG. At the points P and P^1, of the two actual orbits, that of the asteroid lies 0.5 terrestrial radii respectively below or above the Jovian orbit and, having regard to the eccentricity of TG, which, as noted above, is four times that of Jupiter, it is improbable that the two planets can ever approach each other much nearer. In round numbers it has been calculated that their distance can never be less than 70 millions of kilometres.

Should this approach, however, take place, it would in all probability persist for an indefinite period, for through the agency of Jupiter, whose volume exceeds that of TG perhaps 30 million times, the orbit in question would be very materially modified.*

Hitherto the most distant asteroids known have been:—

(153)	Hilda	at a mean distance from sun equal to	3·95 r
(279)	Thule	,, ,,	4·27 r
(361)	Bononia	,, ,,	3 95 r
(499)	Venusia	,, ,,	3 92 r

Of these it is considered that Thule alone could make an appreciable approach to TG, namely at intervals of about 36 years, and to within a distance of 0.07 r, or 10 millions of kilometres.

In the figure the aphelion and perihelion points of (153) Hilda, and (279) Thule, are indicated in A and π respectively.

The diameter of TG is estimated to be from $\frac{1}{30}$ to $\frac{1}{20}$ of the radius of the earth, *i.e.*, from 200 to 300 kilometres, which, for an asteroid is, after all, not so small a value when it is borne in mind that the diameters range from 800 for (4) Vesta, or 700 for (1) Ceres, down to 14 and 10 for (228) Agatha and (452). . . . It is difficult, however, in the present state of our knowledge to arrive at a more accurate estimate of the planet's brightness, one of the factors on which are founded the determinations for the diameter, as the results so far obtained show some discordance, and it is quite possible that in this case, as in others, we have to deal with a variability in intrinsic brightness.

As with the discovery of (433) Eros, eight years ago, the orbit of Mars ceased to form the inner boundary of the asteroidal zone, so in the present case the discovery of TG deprives the Jovian orbit of the privilege of representing its outer limit; and here an interesting consideration suggests itself, for had this important discovery, which thus enlarges the region assigned to the asteroids, been made at a time when TG happened to be in conjunction with Jupiter, it might have been thought for the moment that astronomy had succeeded in adding an eighth member to the Jovian system.

Certain it is, however, that with every advance in our optical means, be they visual or photographic, new surprises are sure to present themselves within our solar system.

* In No. 4094 of the *Astronomische Nachrichten* (May 31st) Prof. Charlier, director of the Lund Observatory, maintains, on the strength of his well-known analytic researches, that in the actual position of TG we have an ostensible proof of a problem divined by Lagrange—the problem, namely, of the three equidistant bodies in an equilateral triangle; or the problem of the perturbations caused by two large masses, the sun and Jupiter, on an infinitesimal mass such as TG, for which problem, he maintains, a definite and final solution can be found. For as the orbits of Jupiter and TG are practically equal, the radii vectores of the planets must be similarly conditioned, and as the elements of Prof. Berberich give to TG an elongation from Jupiter equal to about 60°, which, by reason of the equality in motion, will be permanently maintained, it is clear that the equilateral triangle in question actually subsists in this case, thus offering new and interesting data for future research in celestial mechanics.

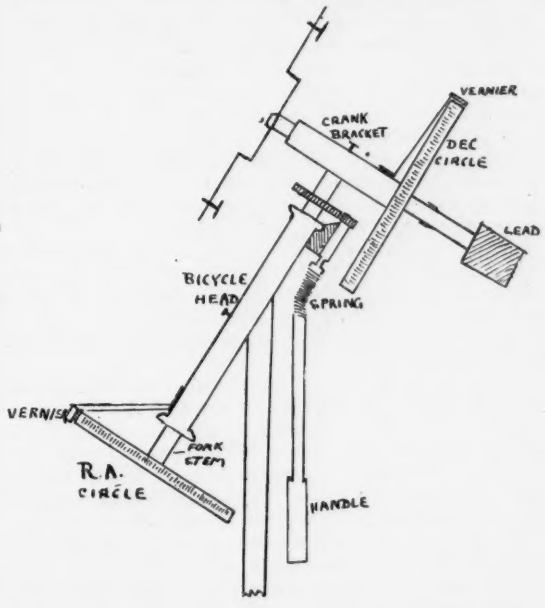
A Cheap Equatorial for Small Telescopes.

By E. W. POLLARD, B.Sc.

MANY possessors of a 3-in. astronomical telescope feel they cannot go to the extent of buying an equatorial head, which may be priced at anything from ten guineas. And yet they know little real work can be done without one. The majority of double stars are never found, and bright planets, like Venus, are frequently near the sun, so that by the time they are visible to the naked eye their image is spoilt by atmospheric refraction and glare.

The writer, feeling this difficulty, has constructed an equatorial from an old bicycle and a few oddments usually found in a jobber's collection; the details of construction may be useful to readers of "KNOWLEDGE."

To form the main support, one of the cross bars of a "diamond" frame is cut off; the ball head is cleared



of all attachments, and the front wheel forks cut off at the base; the handles similarly cut from the handle-bar tube. The centre of the "head" is brazed to the main support at the polar angle; any cycle repairer will do this, and for his guidance a card is cut showing the colatitude angle (about 38°).

The crank bracket is also cleared of attachments, and brazed to the end of the handle-bar tube before-mentioned; this must be done at exactly right angles, and may, perhaps, tax the cycle repairer's patience.

At the free end of the crank spindle a thread is cut to take an ordinary bicycle screw, and a piece of steel to hold the telescope, bent as figured, is fixed on, being secured in position by solder around the threads.

Over the other end of the spindle, which bears the cogged driving wheel, a tube is fixed, carrying at its distal end a lump of lead to balance the telescope.

To make the graduated circles, long brass strips, about $\frac{1}{2}$ in. wide, are procured. The right ascension circle is made from a strip of 576 mm. long; this can be

XUM

divided with a metre rule, each 5 minutes of the circle equalling 2 mm. The result will be a convenient circle having a diameter of about 7 inches. The engraving is easily done with a pointed penknife and ruler, and the markings blackened with solution of antimony chloride (butter of antimony). The figures are preferably in plain English numerals, these being more easily read than Roman. The numbering should be anti-clockwise, from right to left, as it will be the circle that rotates.

Having turned this to a true circle and soldered the ends, a strip is soldered across, forming a diameter, and the centre of this is soldered to the end of the fork stem as shown.

The declination circle is made from a brass strip 720 mm. long, each degree equalling 2 mm. If the cogged wheel of the bicycle is 9 ins. in diameter, a usual size, it will be found that with a little filing of the cogs the strip will exactly go round, and may be fixed in position by soldering at each cog.

Verniers are fitted to both circles as shown; pieces of brass 18 mm. long are divided into 10 equal parts; the R.A. vernier will thus read to 30 secs. and the declination vernier to 6 mins. Thumb-screws are made to clamp in R.A. and declination.

A slow motion in R.A. is a great advantage, and a simple device is to put a cogged wheel (from a clock or similar contrivance) around the handle-bar tube; this can be driven by a smaller cogged wheel fixed to the head; a handle is made by soldering a brass rod to a spiral brake spring, and this to the small wheel. As the telescope rotates on ball bearings comparatively little strength in this slow motion is needed, and the spiral spring, while allowing the handle to be used in any position, does not "give" unduly.

Finally the main support can be let through a mahogany block on a tripod stand, and adjusted to any height, or permanently fixed by cementing it into a large drain-pipe set on a concrete base. Or it can be fitted to a more elaborate stand with levelling screws and artistic masonry.

With regard to the performance of the instrument, that will depend on the care with which it is made and adjusted; there is no reason why any star should not be in the field of view with a low power eyepiece, provided calculations are made from some book, such as the "Science Year-Book," which should be found in every astronomer's library.

As to the cost, an old bicycle can be bought for a few shillings; doing all the work but brazing and thread cutting, the cost to the writer was under half-a-guinea.

The adjustment will probably take some time, and difficulties will be surely encountered, but by the time the amateur has overcome these he will have a very fair knowledge of the "Motion of the Heavens."

ATTENTION is directed to the growth of camphorism, or the habitual use of camphor internally, among the Slovaks of Upper Hungary, by Dr. Aba Sztankay, in *Honte Lapok*, a Hungarian political journal. Dr. Sztankay has kept an eye on the camphor-consumers for the past fourteen years, asking each purchaser of the drug to what use he was going to put it, and he does not think he exaggerates when he states that fully 25 per cent. of the whole amount of the drug sold is used by the camphor-eaters. That the estimate of the quantity of the gum used in this manner must be very considerably increased, is shown by the fact that grocers and other dealers, beside apothecaries and druggists, handle the article. The Slovaks of the region observed by the author are subject to frequent attacks of epilepsy, and this he thinks stands in some relation to the habit alluded to, an opinion that is fortified by the fact which he was enabled to verify, that the administration of camphor was followed by epileptoid convulsions.

Studies in Cohesion.

By DR. ALFRED GRADENWITZ.

THE recent work of Professor St. Leduc, of Nantes, constitutes a considerable advance towards an explanation of certain phenomena characteristic of the life of cells, that is, of the constituents of all vegetable and animal organisms. Though the enigma of the origin of life is hereby in no way solved (nor can a real solution be expected from a continuation of these researches), the mechanism of the phenomena has been explained to a certain extent. The important part played by *diffusion* in connection with all life phenomena of cells has been more especially ascertained, showing the possibility of accounting for the life of living matter, at least as to its external aspect, from a purely physical point of view. These results have recently been completed by experiments showing the no less important part to be ascribed to the force of cohesion. In fact, many phenomena which formerly did not allow of any explanation may now be readily accounted for on physical laws.

By inserting drops of a solution in a differently concentrated solution of the same substance, Leduc has already, a few years ago, constituted artificial cells, the diffusion of the liquid resulting in structures which were entirely analogous in their behaviour to natural cells, and which were exclusively controlled by the laws of diffusion. Now these liquid structures, so far from remaining unaltered, were recently found to undergo a transformation which was not to be explained by the laws of diffusion. In fact, the structures then produced were wholly independent of the distribution of osmotical pressure. If the evolution of the structure be allowed to continue, motions just opposite to those originally produced under the influence of diffusion would be observed, although the direction of forces remained unaltered.

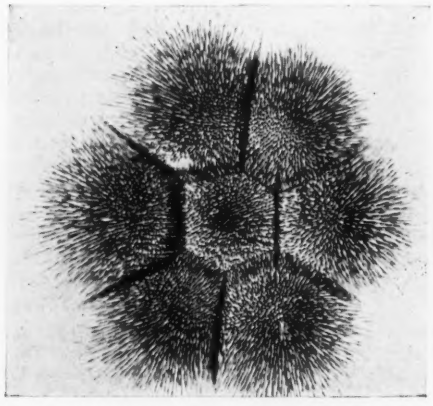


Fig. 1.

If a solution of potassium nitrate be spread out on a glass plate and drops of the same solution, but of smaller concentration, coloured with Chinese ink, be introduced in the former, these drops, owing to the differences in pressure, will be found to diffuse and to result in the liquid structure represented in Fig. 1.

After seemingly remaining unaltered for 5-10 minutes, these continue their evolution. In fact, the carbon particles contained in the Chinese ink, and which at first, owing to diffusion, had left the centre of each of the drops, will go back again in the original direction, tending to combine in the centre of the drops,

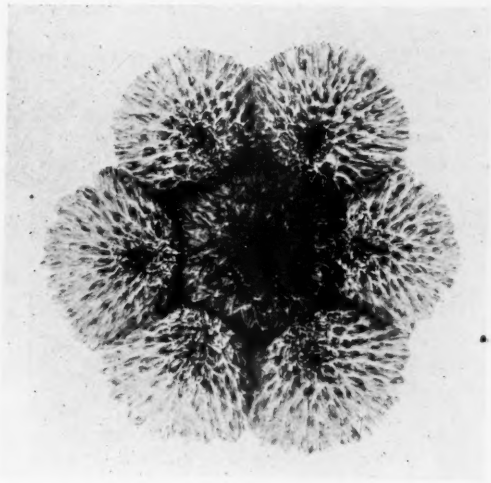


Fig. 2.

while small groups of particles accumulating at the same time in the lines of direction will form ever-increasing grains (Fig. 2), which travel towards the centre of the drops (Fig. 3). If evolution be allowed to continue, the Chinese ink will thus be found to combine in a liquid hectagonal ring, and finally in a homo-

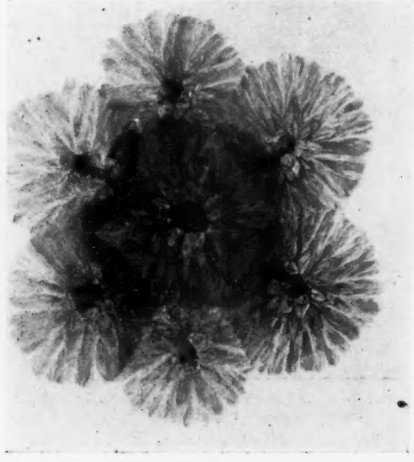


Fig. 3.

geneous mass. A similar drop, as represented in Fig. 4, in natural size, had the dimensions of an ordinary drop (of no more than 3 mm. diameter) on being introduced into the solution, but afterwards, owing to diffusion, reached a diameter considerably higher than that of the photograph, thus assuming the shape of a negative field of diffusion. The drop is afterwards retracted into itself, its centre becoming darker and darker, while its lines of force are separated into ever-increasing grains approaching towards each other and towards the centre of the drop, until they take the aspect represented in Fig. 4.

While not being explained by the action of diffusion, these phenomena are fully accounted for on that of cohesion. In a liquid like the present potassium nitrate solution, containing a microscopical powder such as the carbon particles of the Chinese ink in suspension, the following forces of attraction should, in fact, be considered : (1) The cohesion between the molecules of the solution; (2) that between the particles in suspension, and (3) the mutual attraction between the floating particles and the molecules of solution. An equilibrium will be produced if these forces be strictly equal to each other, which will only exceptionally be the case. Whenever the forces of attraction are, however, unequal, no equilibrium will be obtained unless there is a perfect symmetry round each of the molecules of solution and each floating particle. So far from being stable, such an equilibrium will be discontinued whenever the perfect symmetry ceases. If, *e.g.*, the attraction between the floating particles be considerably stronger than that acting between these

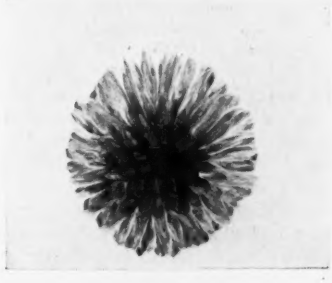


Fig. 4.

and the particles of solution, any accumulation resulting in a disturbance of symmetry will constitute a centre of attraction for other particles, which, by joining the former, will increase their force of attraction. The part incumbent on diffusion now is a double one; it first counteracts the realisation of symmetry in the liquid, setting solid particles and liquid molecules in motion; on the other hand, it carries them into the range of centres of attraction where they come under the sway of cohesion. This is evidently what occurs in the present experiments.

Professor Leduc has, moreover, been able immediately to demonstrate this explanation experimentally by preparing a solution of potassium nitrate coloured with Chinese ink of so precisely the same osmotical pressure as a transparent solution of the same substance, that the coloured drops not penetrating by diffusion into the transparent solution did not undergo any alteration. If, however, the same drops were introduced close to each other, they were found to alter their shape and to be lengthened towards each other, approaching one another, and eventually combining into a sphere. Whenever drops of different dimensions are introduced at equal distances (Fig. 5), the largest drops, exerting a prevalent attraction, will incorporate the small ones. Leduc thus observed (Fig. 5) six small drops arranged around a big one, which, after altering their shape, began travelling towards the larger

XUM

one. This in turn altered its shape, and under the influence of the attraction of the six small drops assumed the form of a hexagon, the least pronounced angle being situated in front of the farthest distant drop.

Now the foregoing effects of cohesion, which had so far been unknown, seem to play a pre-eminent part in connection with certain physiological phenomena. The segmentation of the vitellus (yolk of eggs) during incubation, had, *e.g.*, so far been one of the most enigmatical phenomena of animal life, there being no known physical force under the influence of which a similar effect might have been produced. Now the conditions of incubation are quite similar to those obtained in the present experiment, the high temperature resulting at the surface of the egg in a vaporisation, which, in the surface portion of the yolk, produces a concentration.

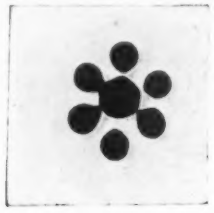


Fig. 5.

Thus currents of liquid (due to diffusion) arise, which in turn, as in the above experiment, must result in a subdivision or segmentation of the mass. The artificial segmentation obtained by Leduc (Fig. 6) will be found to be strikingly similar in appearance to the natural segmentation of the yolk.

Now all lamellar and vacuolary structures in living

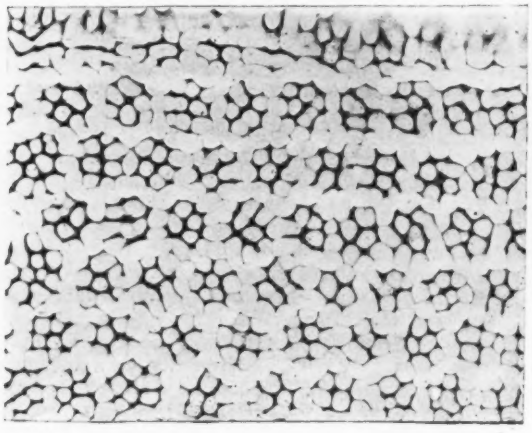


Fig. 6.

organisms are made up of may be obtained in a similar way. Protoplasm in turn consists of the same structures, while those artificially obtained by Leduc show phenomena quite analogous to the lamellar, cellular, and vacuolary structures of living protoplasms. These are retractile, their cohesion increasing in retraction in quite the same way as that of coagulating colloids. In fact, real colloids seem, in the experiments at issue, to be obtainable from solutions of crystallinic substances. This would constitute another transition stage between categories hitherto distinct, while explaining and artificially reproducing the physical mechanism of coagulation. Cells and lamellar structures obtained in

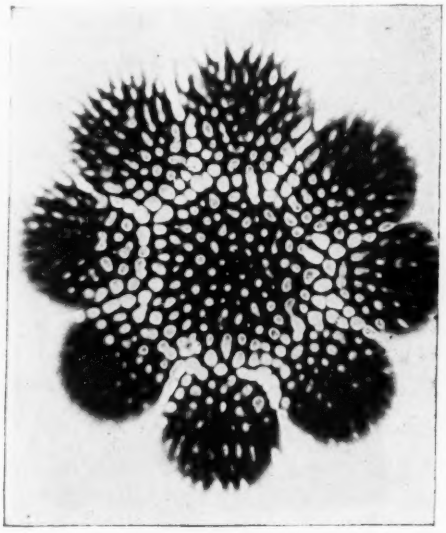


Fig. 7.

virtue of diffusion and cohesion, by the aid of such solutions and in microscopical powder therein suspended, are represented in Figs. 7 and 8.

The same phenomenon would, moreover, afford a

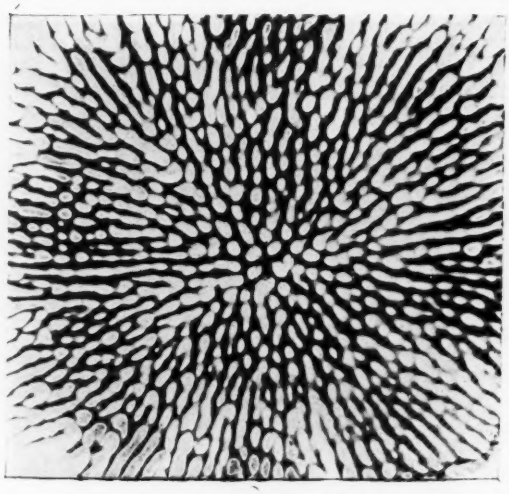


Fig. 8.

physical explanation of the much-discussed phenomenon of flocculation in turbid liquids.

As, finally, the conditions of Leduc's experiments are realised also in natural water, and especially in sea water, in which foreign particles are always in suspension, producing currents of diffusion due to their dissolution; the external agreement in the shape and behaviour of natural organisms and protoplasms on one hand and the artificial structures obtained by Leduc on the other would be fully accounted for.

XUM

British Association at York.

Programme and Prospects.

THIS year's meeting of the British Association assembles under the happiest auspices at York. No place, unless it be a University, is more in harmony with the conduct and spirit of the British Association than a cathedral town, and in none is the hospitality of a more graceful kind. It is twenty-five years since the British Association met at York, there to celebrate its jubilee; and this accident of chronology affords a ready opportunity for a Presidential Address to summarise the work of the past quarter of a century. In Professor E. Ray Lankester, Director of the British

PROFESSOR RAY LANKESTER.

Museum of Natural History, the Association possesses a President whose ability is peculiarly adapted to the task. Professor Ray Lankester is the one British zoologist of genius, and the one authority to whom the work of other men can be referred for critical examination and appreciation. His insight and knowledge fit him to appraise, as his example has fitted him to inspire, the best work of his time and generation in England. Such tributes are tacitly or openly expressed by all those workers in zoology—and in the allied sciences which that substantive includes—whose own work has the merit of insight and originality. But Professor Ray Lankester is more than that to his generation. He is one of the men of science, by no means large in number, who are articulate, whose utterances are coherent in the ears of the multitude, and who is, in the broadest sense, a critic of scientific education and scientific progress. Few men of science in speaking of subjects which are of interest, or which ought to be of interest, to all thinking people, have been responsible for more noteworthy utterances; and few have laboured more—with very little popular comprehension or recognition to encourage them—to advance the cause of science in the nation. It is not customary to disclose any of the particulars of the Presidential Address before its delivery, but it is violating no confidence to say that Professor Ray Lankester's Presidential Address on Wednesday, August 1, will reflect both his critical and proselytising activities; and besides summarising a quarter of a century's progress in science, will deal with the national neglect of science in the schools, by the Government, and in commerce.

The President of the Mathematical and Physical Science Section is Principal E. H. Griffiths, of the University of Wales, much of whose work has been associated with the relation of the units of heat and work. His address will deal, among other subjects, with the present position of the theory of the constitution of the earth's interior, as that theory has been modified by the discovery of radio-active substances.

Besides the papers to be read in this section, which include one by Sir W. Ramsay on chemical and electrical changes induced by ultra-violet light, and one by the Earl of Berkeley on osmotic pressure, there are to be several discussions. Professor Soddy will open one on the evolution of the elements; Mr. J. Swinburne and Dr. H. Rubens, of Charlottenburg, will discuss the radiation from incandescent mantles; and the Hon. R. J. Strutt and Professor J. Milne will speak of the internal structure of the earth. A discussion is also to be opened on the re-measurement of the British geodetic arc.

Professor Wyndham Dunstan is the President of the Chemical Section, and in his address will speak on the necessity for establishing a Central Government Department to deal with the problems of chemistry. Such a department could and would play a most important part in effecting the commercial development of the Colonies, and in regulating and developing the products of the Empire.

Mr. E. W. Lamplugh is the President of the Geological Section, and will open up, no doubt for subsequent discussion, the question of "Interglacial Periods." Professor J. W. Gregory will deal with the palæozoic glaciations of Australia and South Africa, and Professor J. Milne will contribute notes on recent earthquakes. Many papers on Yorkshire geology are a natural consequence of the place of meeting.

Mr. J. J. Lister, F.R.S., is the President of the Zoological Section, and in this section the burning questions of heredity can scarcely fail to be discussed. The subject, however, is not very prominent in the list of papers submitted to the recorders of the section, and the chief subject of general interest appears to be that of the relation of scientific marine investigations in relation to fishery problems.

Sir George Taubman Goldie takes the Presidential chair in the Section of Geography, and will speak on the growth of modern interest in geography. The following papers are promised:—The scientific results of the Scottish Loch Survey, James Murray; The Chagos Islands, Indian Ocean, J. Stanley Gardiner; A Journey across the Sahara, M. E. F. Gautier (not quite certain); The Structure of Southern Nigeria, John Parkinson; The Study of Social Geography, Professor G. W. Hoke, of Ohio State Normal College; A Journey in the Central Himalayas, T. G. Longstaff.

Professor J. A. Ewing, as President of the Engineering Section, will deal with the probable molecular con-

XUM

dition of metals when in a state of strain; and papers on practical engineering subjects, such as Standardisation (Sir J. Wolfe Barry), Glow Lamps (Sir W. Preece), Monophase Electric Traction (C. F. Jenkin), Turbines (C. G. Storey), Waterproof Roads and Dust (Douglas Mackenzie), will be read.

Mr. Sidney Hartland will deal in his Presidential Address to the Anthropological Section with the growing interest in anthropology and the growing recognition of its practical importance by the colonising nations and races. A discussion will take place in the section on early British skulls, and Dr. C. S. Myers will contribute a paper on measurements in the Egyptian Army. Dr. Haddon will speak on South African ethnology; Professor Ridgeway on the origin of the fiddle; Professor Flinders Petrie on Egyptian discoveries in 1906; and there are various papers on Anglo-Roman and Anglo-Saxon remains.

Professor Gotch's address to the Physiologists is one of the most important contributions to controversy during recent years, and states very frankly his position with regard to the subject of "vitalism" in physiological science. It is the most arresting statement of opinion since Dr. Japp's address on the "Nature of Life" some years ago at the Bristol meeting. A discussion is to be opened in this section on the physiological value of rest, and another on minimum diet values. The Chemical Section will co-operate in this discussion.

Professor F. W. Oliver, Quain Professor of Botany at University College, London, will deliver the address to the Botanical Section, taking for his subject "The Seed, as a chapter in Evolution." Three topics have been chosen by the section for discussion:—(1) Some aspects of the present position of Palæozoic botany will be dealt with by Dr. D. H. Scott, F.R.S., and the conditions of growth of Carboniferous plants by Professor F. E. Weiss and Miss M. C. Stopes. (2) The nature of fertilisation and kindred problems, at a joint session with Section D (Zoology). (3) The phylogenetic value of the vascular system of seedlings. Mr. A. G. Tansley and Miss E. N. Thomas will open the proceedings, while Professor Jeffrey, of Harvard, Messrs. A. W. Hill, T. G. Hill, and Miss Ethel Sargant are expected to contribute by papers or otherwise to the discussion.

Professor Michael E. Sadler will deliver the Sectional Address on Education, and the proceedings of the section will be rich in discussions on "Health in Schools," the "Curriculum of Primary Schools," and "The Teaching of Modern Languages."

Mr. A. L. Bowley will preside over the Section of Economics and Statistical Science, and will take for the subject of his address the importance of true scientific method in statistical research.

MR. CHESTER TENNANT, of Dawson, in the Yukon, furnishes us with some curious particulars on the things that happen when the mercury in the Fahrenheit thermometer goes to 60 deg. or 70 deg. below freezing. The steel of edged tools becomes so brittle that it will break almost as readily as glass under sudden strain or shock; spikes of nails used in the wooden-built houses contract; coal oil begins to thicken and solidify till it assumes the consistency of lard; and a lighted lamp left out in the cold goes out in about an hour because of this reason. Every stovepipe in the township throws out a great cloud of steam and vapour, and a consequent white grey mist, or haze, remains permanent in the atmosphere, so that there is always a sort of frozen fog in the day time. Even people exhale this fog, like locomotives, and the breath roars out like a mild jet of steam.

Photography.

Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

Ozobrome.—This curious word is derived from "ozone" and "bromine," though it indicates a process with which ozone has nothing to do, and bromine very little. It is a method recently patented by Mr. Thomas Manly (who, a few years ago, introduced the ozotype process), by which a bromide print is made to furnish one or several carbon prints. This means that the facility of making a bromide print either by contact or enlarging methods, necessitating only a few seconds' exposure to artificial light, may be combined with the advantages of carbon or pigment prints with their permanency and the wide choice of colours that they permit. Indeed, the new method presents notable advantages as compared with the ordinary carbon process, for not only is daylight unnecessary for the exposure, but the print is not laterally reversed though there is no double transfer, and in one modification no transfer at all. The principles involved are very simple. The bromide print consists of a metallic silver image in a gelatine film. Silver is in many cases a very efficient reducer, and by bringing into contact with it a pigmented gelatine film sensitised with a bichromate, the silver, directly or indirectly, reduces the chromate, much as exposure to light would, to a chromium compound which renders the gelatine insoluble.

The practical details run on the following lines: A bromide print, which may be an old one, but must have been thoroughly washed, is soaked in a formaline solution for a few minutes to harden the gelatine, and washed. The carbon tissue or "pigment plaster" that is to be used is soaked till limp in a solution that contains an alkaline bichromate, ferricyanide, and bromide, while the bromide print is soaked in water, and the two squeegeed together. If one print only is required, after a few minutes the print is plunged into hot water and developed in the same manner as a single transfer carbon print. But if desired, the same bromide print will furnish several carbon prints, by plunging the original with the carbon tissue squeegeed to it into cold water, separating them gently, and then treating the carbon tissue exactly as if it had been just exposed to light in ordinary carbon printing. The short contact with the original is equivalent to the otherwise necessary, and often prolonged, exposure to daylight under the negative. The silver of the bromide print is changed into a silver salt, but immersion in an ordinary developing solution reduces it to the metallic state, and so it can be used over and over again. It seems that all carbon tissue is not suitable, and that a specially soluble kind is supplied by the patentee. Full working details will probably be obtainable before this is published, together with modifications and other applications of the process.

This process seems, on the face of it, to have so much to commend it that the essential difference between it and carbon printing by the ordinary methods must not be lost sight of. Carbon printing, as hitherto practised, is a printing-out process, and the charm of a carbon transparency, as well as its reliability for reproduction purposes, lies largely in this fact. Probably no method gives a more exact representation of the negative, for the possibilities of altering the gradation by accident or design are hardly worth consideration. But

in the "ozobrome" methods, the result depends upon development in the same sense in which the negative is developed, and while this may sometimes be an advantage to the skilled worker, it renders all sorts of errors possible. This radical difference must ever be borne in mind.

Specially Sensitised Plates.—Since my notes of two months ago were printed, I have received from Messrs. Wratten and Wainwright samples of their specially sensitised plates. There are four kinds, all essentially different from the ordinary "isochromatic" plates, in being so much more sensitive to red, and therefore to yellow, that yellow colour screens, that generally need the exposure to be increased to ten times, with these plates require only about a doubled exposure. The "verichrome" plate may be developed in a deep red light, but no light is safe for the others, except that a very weak green light might be used with the pinacyanol-bathed plates. These last are extraordinarily sensitive to red. The pinachrome-bathed plates are very sensitive to red, but less than the pinacyanol plates, and they are more sensitive to green. Without doubt, the most useful for general purposes are the "verichrome" plates, for moderate red sensitiveness, and the "panchromatic" plates, if extreme red sensitiveness is wanted, and as these are not called bathed plates, I presume that the emulsion is sensitised before the plates are coated. The plates are all of high general sensitiveness, the H and D figure ranging between 100 and 200, and they all give good gradation. Each box contains a card that gives the sensitiveness on the H and D, Watkin's and Wynne's systems, the time required for development at 50°, 65°, and 80° F., besides other information.

Received.—Messrs. Taylor, Taylor and Hobson have sent me a flexible releasing arrangement, on the Bowden wire principle, for the shutter referred to last month. It is of excellent design and workmanship, and is attached to or removed from the shutter in a moment by a bayonet joint. Such releases are much to be preferred to pneumatic balls, because they have no indiarubber in them to perish, and they give a positive rather than an elastic push. I have so far found only one disadvantage, namely, that if a comparatively short bend is necessary, as may be in some hand cameras, it will cause too much friction in a Bowden wire before it interferes in any way with the flow of air through a tube.

The "Imperial Handbook for 1906," is chiefly a collection of useful hints and data for those who use photographic materials. It includes a price list of the Company's manufactures, and the recommended formulæ for their treatment.

The "Photo-Miniature" for last December, price 6d., is just to hand. It is a useful little volume on bromide printing and enlarging.

Vitality of Seeds.

To the disputed question of the vitality of dried or buried seeds a new contribution has been made by M. Fliche, a French botanist. In the Forest of Hane some years ago he was astonished to find large quantities of a plant called cypress-spurge, or wolf's milk, in blossom. It is a plant well known in Italy, but not indigenous to France. Two years later the plants entirely disappeared. Similarly another growth, in another clearing of the forest, was unearthed, and this in its turn flourished and disappeared. The obvious botanical reason for the disappearance of a plant is that it is choked in the struggle for life by the existence or overgrowth of other plants better suited by the environment; and that the cypress-spurge, not finding itself able to cope with its surroundings, disappeared.

NOTES.

ASTRONOMICAL.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S.

Origin of Lunar Formations.

IN the annual report of the Paris Observatory for 1905 M. Loewy briefly discusses the results of a very thorough investigation of the lunar photographs which have been obtained with the great equatorial Coudé, in preparation of the 9th volume of the Atlas Photographique de la Lune. Endeavouring to find possible causes of the peculiar formations of seas and mountains, three distinct sources are tabulated:—(*a*) They may be due to meteor swarms circulating round the sun; (*b*) projections from terrestrial volcanoes; (*c*) they may have been detached from the earth while still fluid, and have circulated round in orbits only slightly differing from that of the moon. Examining these in detail, the first two are found to be incapable of explaining the known phenomena, and it is concluded that the third suggestion is the more probable, the annexation of the ring of satellites at intervals, while the surface of the moon was sufficiently condensed to enable the masses to become attached without being entirely absorbed and their individual forms eliminated.

Return of Finlay's Comet.

Following close on the publication of the Search Ephemeris by M. L. Schulhof, we have the announcement of the rediscovery of Finlay's comet, under conditions which promise to permit of more favourable observations than during its previous apparition in 1886. Perihelion passage is computed to take place on September 7·5, and the brightness of the comet on June 18 about twice as bright as when discovered in 1886, its brilliancy probably steadily increasing up to the end of August.

The announcement of its re-discovery at Koenigstuhl was made by telegram, giving the following position:—

	h.	m.			d.	h.	m.	
R.A. =	23	38·3	}	(1906. July	16	13	14·4	Koenigstuhl M.T.)
Decl. =	−14°	3′	(S)					

The object is travelling in a north-easterly direction, and is described only as bright.

Report of Observations of Total Solar Eclipse, August 30, 1905.

The reports of observations made by members of the British Astronomical Association of the total solar eclipse of August 30, 1905, have now been issued together in a most attractive and interesting volume, covering almost all sections of eclipse investigation. The main expedition was stationed at Burgos, under the direction of Mr. C. Thwaites, the duration of totality being about 3m. 45s. The sun remained covered with clouds up to within 15 seconds of totality, when suddenly a rift appeared, through which the eclipse was observed. The corona was seen of a pearly white colour, not so bright nor with so long streamers as the corona of 1898. It was, in fact, a typical sun-spot maximum corona. Numerous drawings of the corona are given as seen at various stations along the line of totality, and a reproduction of a beautiful photograph taken by the Rev. A. L. Cortie at Vinaroz with a 4-inch objective of 19 ft. 4 ins. focal length, fed with light from a 8-inch coelostat mirror.

Especially interesting on account of the meagre spectroscopic results obtained by the more powerful equipments of the unfortunate expeditions is a reproduction of a very clear spectrogram of the flash spectrum taken by Mr. E. Dickson at Burgos. This was taken with a fixed half-plate camera

XUM

of 15 ins. extension fitted with a single Wray lens and a Thorp replica grating; it shows the chromospheric spectrum in excellent focus from Hβ to the extreme ultra-violet.

Objective Prism Comparison Spectrograph

Various suggestions have been made in recent years for the utilisation of the large light grasping power of objective prism spectrographs in radial motion determinations, the chief difficulty being in the production of a suitable comparison spectrum owing to the absence of a slit. Mr. De Lisle Stewart proposes to employ two prismatic cameras mounted together, with their axes inclined, say, about 15° to each other. These will give two spectra close together on the photographic plate, but in reverse order. Two smaller lenses of equal or greater focal length than the main objectives would be placed in the central line of the apparatus, one to serve as guiding telescope and the other to photograph a reference image or trail of the star on the plate. By placing the two prisms in these positions it is hoped to avoid many of the flexure difficulties hitherto encountered in this work.

CHEMICAL.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

Air that Extinguished Flame.

IT was recently noticed in a cold storage that candles or lamps began to burn with a feeble flame as soon as they were brought into the room, and that in many parts of it they were extinguished. A match could be lit, but the wax would not ignite. In the corner of the storeroom was a disused well, from which gas issued, and Mr. Bertram Blount, who was asked to investigate the cause of the trouble, at first supposed that carbon dioxide was being distributed into the air from this well. But this was not borne out by analyses of the air in the room and from the well; for the amount of carbon dioxide was only slightly more than is present in normal air, and was quite insufficient to have affected the combustion of a candle. Samples of air taken from different parts of the room contained only 17.5 to 17.7 per cent. of oxygen, or from 3.2 to 3.4 per cent. less than is present in normal air. The oxygen in the air in the shaft of the well amounted to no more than 8.6 to 8.9 per cent., and other experiments confirmed the conclusion that the air in the storeroom was ordinary air containing less than its proper proportion of oxygen, owing to admixture with air deprived of its oxygen, which issued from the well shaft. The source of the impoverished air from the well was finally traced to tunnelling operations close by, in which compressed air was being used. This air must have found its way through the soil wherever it was sufficiently porous, and so into the shaft of the well, and on its passage through the soil must have been deprived of part of its oxygen by contact with some substance such as pyrites. Evidence in support of the correctness of this conclusion was furnished by the analysis of the mud from another well shaft near the first. This mud was found to contain pyrites, and air left in contact with it for some weeks was deprived of almost the whole of its oxygen.

Bologna Phosphorus

In 1760, Canton made the discovery that when oyster shells were calcined with sulphur in a crucible at a red heat, there was produced a phosphorescent substance, which he regarded as a form of phosphorus, but which was really an impure calcium sulphide. The so-called "Bologna phosphorus" thus obtained has found a commercial use as the luminous basis of phosphorescent paints. The luminosity does not appear to be due to a slow process of oxidation, since it has been found that a preparation that had been sealed up in an air-tight tube for a century still phosphoresced. Zinc sulphide has the same property of being luminous in the dark. It has recently been observed by Signor Vanino that the phosphorescent sulphides of calcium or zinc can act upon a photographic plate in the dark through a layer of black paper, but that all action is checked by placing celluloid between the substance and the sensitive film. Since radio-active preparations of lead can act readily through celluloid, it would seem that the action of the phosphorescent sulphides on the plate is not due to β or γ radiations (which can pass through celluloid), but to traces of sulphuretted hydrogen, given off by the sulphides, being capable of penetrating the paper, but not the celluloid. Signor Vanino also finds that the presence of calcium fluoride enables one to obtain an actively phosphorescing sulphide at a much lower temperature than is commonly used. The preparation may also contain a large amount of inert substance, and only a small proportion of calcium sulphide, and yet be very luminous.

The Identification of Horse-Flesh.

One of the most difficult problems that the chemist is called upon to solve is the identification of horse-flesh in sausages or other flesh foods. It is well known that enormous quantities of horse-flesh are eaten, chiefly in the form of sausages, on the Continent, but in England the strong prejudice against its use, the heavy penalty for selling it without a notification, and the fact that there is a ready sale abroad for broken-down horses, all tend to render its use in English sausages unusual. Apart from the specific serum test ("KNOWLEDGE & SCIENTIFIC NEWS," Vol. II., p. 86), which has not as yet come into general use, there are practically only two methods of chemical examination, the determination of the characteristics of the fat and the detection and estimation of glycogen or animal starch. The fat of the horse is of a much more oily nature than the fat of other domestic animals, and being composed of more highly unsaturated glycerides, is capable of combining with more iodine. But, although an examination of the fat, especially of that deposited between the muscular fibres, is fairly conclusive in the case of pure horse-flesh, it is unsatisfactory for mixtures, and more reliance is usually placed on the glycogen test. Glycogen is identical in chemical composition with ordinary potato starch or wheat starch, but, unlike them, gives a red instead of the well-known blue colouration with iodine. It is found in the liver and blood of many animals, and may amount to as much as 1.5 per cent. in the muscular fibre of the horse. It is also present in the flesh of the mule, but not to any extent in that of the ass. Herr Martin, who has recently published the results of his experiments, finds that any trace of glycogen in beef, veal, pork, or mutton soon disappears from the flesh, whereas in the case of horse-flesh and the flesh of fœtal animals, it can be detected and estimated for days after the animal was slaughtered. He attributes the greater stability of glycogen in horse-flesh to the blood of the horse having only a slight fermentative action as compared with the blood of the ox or sheep. Herr Niebel, some years ago, came to the conclusion that the reaction with iodine was uncertain, for he found that glycogen was also present in the flesh of dogs, cats, and very young calves, in the livers of cattle, and in meat extract. Herr Bujard, again, found that the amount of glycogen and its distribution through the body of the horse was influenced by the food given to the animal, and by its state of health, and considered that results obtained by this and similar methods should only be regarded as a confirmatory test. Another drawback is that the glycogen is destroyed by smoking the flesh, and that the presence of ordinary starch masks the red colouration that glycogen gives with iodine.

GEOLOGICAL.

By EDWARD A. MARTIN, F.G.S.

The Enchanted Mesa.

IN the Journal of the Franklin Institute for June, there is an extremely interesting paper by Professor Oscar Carter, on the Plateau Country of the South-West, where is found what is known as the Enchanted Mesa. The mesa is not now inhabited, although sufficient evidence has been adduced to show that at one time, at any rate earlier than 1540, it was occupied by the Pueblo Indians, whose cliff-city of Acoma is some three miles distant, and is built on

a mesa, with precipitous sides. The grassy trough in which the mesas occur is a wide canyon-like valley, more than ten miles long, by two to four miles wide, and it is itself surrounded by vertical walls. This valley has been carved out by erosion into curious and bizarre forms. The strata of the plateau, by the dissection of which the mesas have been left high and dry, consist of variegated layers of sandstone, shale, and limestone, "of Palæozoic and Mesozoic ages," and lie as a rule with but a slight dip. The plateau itself is from 4,000 feet to 8,000 feet above tide, and the mesa rises precipitously from the flat plain, which forms the canyon-like valley, to a height of 430 feet from the middle of the plain. The name of the Garden of the Gods has been poetically applied to the valley, and undoubtedly it is of immense interest from the archæological as well as from the geological point of view.

New Fossil Walrus.

In the *American Journal of Science*, for June, a magazine which was founded by Benjamin Silliman, as far back as 1818, we note a description of a new genus and species of walrus founded on a left mandibular ramus, which was discovered by a student of the John Hopkins University, Mr. W. E. Curley, on a beach, at Yorktown, Va., a Tertiary littoral deposit. It has been named *Prorosmarus alleni*.

Diplodocus.

Mr. W. J. Holland has described in "The Osteology of Diplodocus Marshii" the additional material which has been collected since Hatcher's account was first published. He also gives an account of the restoration of *Diplodocus* recently presented to the British Museum. He includes a detailed description of the atlas, sternal plates, and the bone supposed to be the clavicle. The dorsal, sacral, and caudal vertebræ, and the chevrons, are also included in the description.

Some London Borings.

The varying depths under London at which the chalk has been tapped in deep wells is shown by some recently-made borings, conducted by Messrs. C. Isler and Co. At Kentish Town (Prince of Wales Road Baths) there was 124 feet of London clay, 46 feet of Woolwich and Oldhaven beds, and 34½ feet of Thanet sands, above the chalk, which was reached at 205½ feet. At the Baltic Exchange, E.C., the chalk was found at 211 feet, there being 112 feet of London clay, 42 feet of Woolwich and Oldhaven beds, and 57 feet of Thanet sands and basement beds. In the Woolwich beds there is included a thickness of 20 feet of "black rock." This, probably, represents the coaly or lignitic layer which is sometimes found in the series. The thickness is, however, unusual. At Upper Clapton (Lea Valley Works), the chalk was met at 120 feet, but across the river, at Camberwell (Warner Road), the chalk had sunk to 163 feet, whilst eastward therefrom it rose again to 134 feet at Church Street, and to 135 feet in the Old Kent Road. This is in accordance with the well-known rise of the chalk at the inner south-eastern corner of London, whilst at the extreme opposite corner the chalk, already noted at Kentish Town as at 205½ feet, sinks still further at Willesden Junction (Acton Lane), to 340 feet. At the last mentioned place the chalk was pierced, and attained a thickness of 580½ feet, the gault being bored to the extent of 80½ feet, with no intervening upper greensand. The total depth bored was 1,000½ feet, and the well must be considered one of London's deeper wells.

ORNITHOLOGICAL.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c.

Black-Footed Penguin Breeding in Confinement.

THE small rookery of black-footed penguins, *Spheniscus demersus*, recently established in the gardens of the Zoological Society of London, is thriving; so much so, that a pair have just succeeded in hatching out two nestlings, while another pair have made a crude nest of sticks, but so far no eggs have been laid.

The eggs of the first pair were laid at intervals of three days, the first being laid on May 24, the second on the 27th. Incubation lasted five weeks, and did not begin until the second egg was laid. The site selected for a nursery was a shelf of rock about half way up the cliff of the sea-lions' pond; while the second pair have chosen a place much lower down, and in a cave-like recess, thus more nearly resembling the burrow in which these birds usually build.

The work of incubation was undertaken by both parents, and both share in the work of feeding the young, a task which is performed by inserting the bill within that of the nestling, a method exactly opposite to that practised by the cormorants and some other species.

Although this is the first time that this bird has bred in these gardens, young have been reared in the Jardin d'Acclimatation, in Paris.

Peregrine Falcon Breeding in Yorkshire.

Mr. T. H. Nelson, in the *Field*, June 23, records the welcome news that a pair of peregrine falcons have succeeded in rearing a family of three during the present nesting season, thanks to the co-operation of the cliff-climbers of Bempton. It is just a quarter of a century since a pair of this species performed a similar feat. Mr. Nelson expresses a hope, in which all bird lovers will share, that the parent birds will not be molested during the coming shooting season; since, should they be spared, we may, as he remarks, see this ancient haunt re-tenanted, and thus an added interest will be secured to the magnificent cliff scenery of the Yorkshire coast.

Roller in Scotland.

The "Annals of Scottish Natural History" for July contains a record of the fact that a roller, *Coracias garrula*, was seen at Balnacoil, on the Brora, on May 28. The bird was watched for several days, its favourite perch being the end of the bare branch of a tree.

Iceland Falcon in Lewis.

Mr. J. A. Harvey Brown writes to the "Annals of Scottish Natural History" for July, to say that an Iceland falcon, which had been watched during several days on the Eye Peninsula, Lewis, was shot on February 28.

Honey Buzzard in Fife.

On May 21, according to the "Annals of Scottish Natural History" for July, a honey buzzard "was unfortunately shot" on the Largo Estate. It had apparently been seen hovering over a field in which young pheasants were being reared.

PHYSICAL.

By ALFRED W. PORTER, B.Sc.

Radium and Electric Discharge in Tubes.

A FEW years ago, Wehnelt showed that the difference of potential required to produce a discharge through a vacuum tube is very much diminished if the cathode be coated with an oxide of one of the metals of the alkaline earths, such as barium oxide or calcium oxide, provided that the cathode is then raised to a red heat by means of an independent current. Mr. A. A. Campbell Swinton has quite recently tested whether radium coated on the cathode produces the same effect. Moreover, as radium gives off electrons when cold, it was anticipated that it might be unnecessary to heat the cathode. Using a cold cathode with a thin coating of the bromide of radium, and with a continuous current up to 400 volts pressure, this was found not to be the case. A very marked action in facilitating the production of a luminous discharge was, however, observed when the radium-coated cathode was heated; in fact, a pressure of 80 volts was then sufficient. Further experiments showed that it is not sufficient that the radium be in the tube; it must be on the cathode for the effect to occur. Whether the radium salt is more or less efficient than barium or calcium

oxide is rendered doubtful owing to the very small amount of radium employed. With the quantity actually used the efficiency was less, but this might not be the case if more radium were available.

Decay of Radium A, B, and C.

Dr. H. L. Bronson is continuing his researches on the decomposition products of radium, and claims to have proved—

(1) That within the limits of experimental error the experimental decay curves agree with the theoretical decay curves, calculated on the assumptions that the three products, A, B, and C are successive, and that their periods are 3, 26, and 19 minutes.

(2) That radium B emits Beta-rays of less penetrating power than those from radium C; and that on this account the Beta-ray decay curves are unsatisfactory for the purposes of analysis.

(3) That these Beta-rays from radium B completely explain the divergence which Rutherford found between the experimental and theoretical Beta-ray curves.

Image in a Concave Mirror.

If a lighted candle be placed in front of a concave mirror between the focus and the centre of curvature, a real inverted image of it upon a screen can be obtained in a definite place beyond the centre of curvature. If the candle is placed so that this image is fairly distant, anyone looking into the mirror will see a second image of the candle apparently behind the mirror. Now since the rays from any point of the candle must be converging after reflection to a point on the real distant image, it follows that the image seen in the mirror must be seen by means of converging cones of rays. Any eye which sees this image with anything like perfect definition must be able to adjust itself to more than infinitely distant objects. Short-sighted people will not see the image except as a blurr of light. But it is astonishing how well-defined it can appear. And it is still more astonishing that, as far as I am aware, no text-book contains any account of this phenomenon. Instead of a candle, the observer may examine the image of his own face in this way, and it is interesting to observe the changes as the observer draws close to the mirror, when, of course, the usual, erect vertical image is obtained. Those interested in this question are recommended to draw the rays, in various cases, by which the images are seen.

The Magnetisation of a Magnet.

A curious misconception in very elementary text-books is as to the portion of an ordinary bar magnet which is the more highly magnetised. Examinees tell one *ad nauseam* that it is the ends which are so. Of course, it is near the ends that most external evidence is obtained of the bar being magnetised at all; that is, it is there that the so-called free magnetism is in evidence. But though it is perhaps not quite so obvious how to obtain proof of the statement, it is nevertheless true that it is the middle of the magnet that has the greater magnetisation. Those who are familiar with the molecular theory of magnetisation, which attributes magnetisation to the alignment of already existing molecular magnets, should have no difficulty in realising this fact, for it is clear that the reversing action of the free poles at the ends will tend to make the alignment less perfect near them. The fact that lines of force leave the magnet in the neighbourhood of the poles also points to the same conclusion; for it indicates that there must be more lines passing through the centre than near the poles, the rest having escaped. The simplest experimental proof is from the phenomena of induced currents. A coil of wire connected to a galvanometer is traversed by an induced current not only while the coil is being brought up to the pole, but while it is moved by stages over the magnet from pole to centre. The induced flow is due to the change in the number of magnetic lines threading the coil, and the direction of the flow is that corresponding to an increase in this number, as the centre is approached. The confusion, of course, is between magnetisation and free magnetism. Near the centre the magnetisation is great, but practically no free magnetism shows itself, because north and south kinds are present together in nearly equal quantity. Near the ends the magnetisation is less; but free magnetism, either north or else south, is conspicuous because there is very much more of one kind than of the other.

ZOOLOGICAL.

By R. LYDEKKER.

The Sea-Serpent.

INTEREST, for the moment, is concentrated on the account given at the meeting of the Zoological Society on the 19th of June by Messrs. Nicoll and Waldo, of their experiences of the sea-serpent, when cruising off Para on the morning of December 7 of last year. That these gentlemen, both experienced observers, saw some huge marine animal cannot be doubted; while their description of such portions of it as came under their notice does not enable us to refer it to any known group of living vertebrates. An especially noteworthy feature is that the description tallies remarkably well with that of the monster seen many years ago by the officers of *H.M.S. Dædalus*. Two great difficulties enter into the question of the existence of a sea-serpent, namely, the absence in Tertiary formations of the fossil remains of any such animal, and the infrequency of its appearances. Being presumably an air-breather (as otherwise there would be no occasion for its ever coming to the surface), it should make its appearance at comparatively frequent intervals, and, therefore, ought to be seen not uncommonly.

The Indian Ocean.

At a recent meeting of the Royal Geographical Society, an important communication was made by Mr. J. S. Gardiner concerning the natural history and mode of formation of the Indian Ocean, based on an exploring expedition undertaken in *H.M.S. Sealark*. One of the problems specially considered was the manner in which the land-bridge formerly connecting Madagascar with Ceylon and India was removed. In the author's opinion, this was effected entirely by currents; but in the discussion it was pointed out that these could not have formed the basin of the Indian Ocean, which can scarcely be due to anything but subsidence, and consequently that the later changes were probably also due to the same agency.

The Fins of Fishes.

A controversy has been long in existence with regard to the origin of the paired fins of fishes, and thus the limbs of vertebrates generally. According to one theory, these fins are derived from gill-structures; the arches, or supports, of the gills having become modified into the shoulder-girdle (scapula and coracoid) and pelvis, while from the gill-flaps, with their supporting gill-rays, the fins themselves have been evolved. According to the alternative view, the fins are modified portions of a longitudinal fold of skin running along each side of the body. It is to be hoped that the controversy may be finally closed as the result of a paper communicated by Mr. Goodrich, of Oxford, to the June issue of the *Quarterly Journal of Microscopical Science*. Attention is there directed to the fact that the paired fins and the median fins are structurally similar; and that while this is in perfect accord with the lateral-fold theory, it cannot possibly be explained by the gill-theory.

South America and Africa.

In the course of a paper on the freshwater fishes of South and Central America, published in the June issue of the *Popular Science Monthly*, Professor Eigenmann expresses his opinion with regard to another much-debated question, namely, a former land-connection between South America and Africa.

"In the earliest Tertiary," he writes, "tropical America consisted of two land-areas, Archiguiana and Archamazonia, separated by the lower valley of the Amazon, which was still submerged. There was a land-mass, Hellenis, between Africa and South America, possibly in contact with Guiana and some point in tropical Africa. This land-mass, which

was inhabited, among other things, by fishes belonging to the families *Lepidosirenidæ* (lung-fishes), *Pœciliidæ*, *Characinidæ*, *Cichlidæ*, and *Siluridæ* (cat-fishes), sank beneath the surface of the ocean, forcing the fauna in two directions, towards Africa and towards South America, and exterminating all types not moved to the east or to the west. From these two rudiments have developed the present diverse faunas of Africa and South America, each reinforced by intrusions from the ocean and neighbouring land-areas, and by autochthonous development within its own border. . . . The connection between Africa and South America existed before the origin of present genera, and even before the origin of some of the present families and sub-families, some time before the early Tertiary. There has never been any exchange between Africa and South America since that time."

Papers Read.

At the meeting of the Zoological Society, held on May 29, Messrs. Schwann and Thomas furnished a paper on Transvaal mammals; Mr. F. E. Beddard contributed notes on the vascular system of the Arizona poisonous lizard and certain other reptiles, and likewise described the external characters of a fœtal giraffe; while Dr. R. Broom gave a description of a South African fossil reptile. At the closing meeting of the session, held on June 19, Sir C. Elliot discussed the nudibranch molluscs of India and Ceylon; Mr. Rothschild described as new a zebra from Rhodesia; Drs. Brady and Chilton respectively contributed papers on the freshwater crustaceans of New Zealand, and Mr. Regan discussed the classification of sharks and rays.

CORRESPONDENCE.

"Eolithic Man."

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—I am inclined to ask if we are justified in endorsing M. Rutot's conclusion that Eoliths represent a period of stagnation in the practice of flint knapping? Hitherto the gradual improvement in Eolithic implements has been one of our mainstays in proving the authenticity of these forms, and the abandonment of this position will go some way towards the elimination of Eoliths as authentic records of pre-Palæolithic man. Neither can I follow M. Rutot's explanation of this supposed stagnation. The flints of Tertiary deposits are chiefly pebbles of small size, hard and irregular of fracture, and unsuited for the manufacture of implements; it was only during the post-Tertiary and more active denudation of the chalk that the more suitable flints were disinterred—hence in Eolithic implements of the earliest types we have small forms which might well have been manufactured from the small fragments lying ready to hand. Before that more active denudation the chalk was in a large measure covered by Tertiary, and therefore unsuitable, *débris*. If there was anything in the nature of a stagnation—a very unsatisfactory term in any evolutionary discussion—it was, I think, attributable to slow development of intelligence on the part of pre-Palæolithic man.

I would add that the photograph reproduced in your April number, although excellent as an illustration, cannot be taken as any argument against Eoliths. It is impossible to show by photography the differences between the Mantes pseudo-Eoliths and the genuine antiquities; the two forms must be closely studied side by side. At the same time, as I have before maintained in your pages, these pseudo-Eoliths must be eliminated from the argument, for they were produced by an essentially artificial arrangement.

It is only when an extensive series of implements is exhibited that the full evolutionary value of Eoliths can be properly estimated. If these forms are merely natural, then there should be an absolute identity of finish, but from the rudest Eolith to the finest Palæolith there is a connecting sequence, and there is no form at which it is possible to draw the line between Eolithic, or "natural" forms, and Palæolithic, or artificial forms, and this impossibility confronts our opponents for solution. There are forms which may be termed either late Eoliths or early Palæoliths; in which aspect the question at issue is reduced to one of mere terms and not facts.

J. RUSSELL LARKLY.

Buenos Aires, South America,
June, 1906.

Sand Mist in China.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—I reside in Central China, on the river Yangtsi, 1,000 miles from the sea. The district is hilly. At certain times of the year, especially spring and summer, we are visited occasionally with sand storms. These are not blinding and thick like those met with in the North of China. They are sufficient to obscure the vision of the hills across the river, and to make everything like in a mist.

These storms generally come on with a strong wind from the north-east, but the cessation of the wind does not mean the settling of the sand. That continues to hang about for days, till a heavy shower of rain settles it.

That the sand or dust does not come from a local source can be proved from the fact:

That we have these storms when there are no sand-banks in the neighbourhood uncovered.

That the sand by the river is not fine enough to be suspended in the air after the wind has ceased to blow.

I write at this time to mention a peculiar phenomenon in connection with the last storm we had, on April 8.

On the Sunday morning, the air was most wonderfully clear, the hills, miles away, seemed near and distinct. By the afternoon a change came on, and a wind sprang up. That evening, and the next day, the air was quite obscure with sand or dust. On Monday night we had some rain and the sand was settled. As I was walking down the river-side on the next afternoon with a companion, we noted round the numerous rain pools which had partly evaporated, a ring of pure sulphur. This was not only in one small defined area, but as far as we walked and wherever there were these partly dried-up pools. As my companion was a doctor, his judgment could hardly be wrong that the substance was sulphur. Never before in my residence in this place have I noted such an occurrence.

Now, the question is, where did the sand or dust come from that had suspended with it so much sulphur? Could it have any connection with the recent eruption of Vesuvius?

It would be interesting to know if any of your readers noted anything of the same elsewhere, or can give any explanation of this in Central China.

I remain, yours truly,

WM. DEANS.

Church of England Mission,
Ichang, China.
April 23, 1906.

To Make Iron Grow.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—In connection with Mr. Badgley's letter, it appears desirable to point out that a "globular molecular theory" (whatever that may mean, for this is not clear from the letter) involves a contradiction of terms. A "molecule" in physics has a certain definite meaning, and is characterised by certain definite properties, and the phenomenon in iron is easily accounted for consistently with these properties. There are plenty of treatises on physics from which your readers can obtain information as to theories of the constitution of matter, but any attempt to discuss even well-known theories in the limited space available in your columns is likely to be worse than useless. If Mr. Badgley believes he has discovered a new theory of matter, his best course would be to treat the subject closely on the lines of such standard treatises on the Kinetic Theory as those of Watson, Burbury, Jeans, or Osborne Reynolds. The method of exposition is all-important.

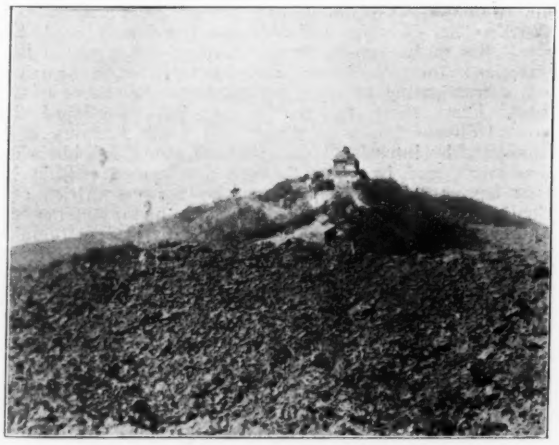
G. H. B.

XUM

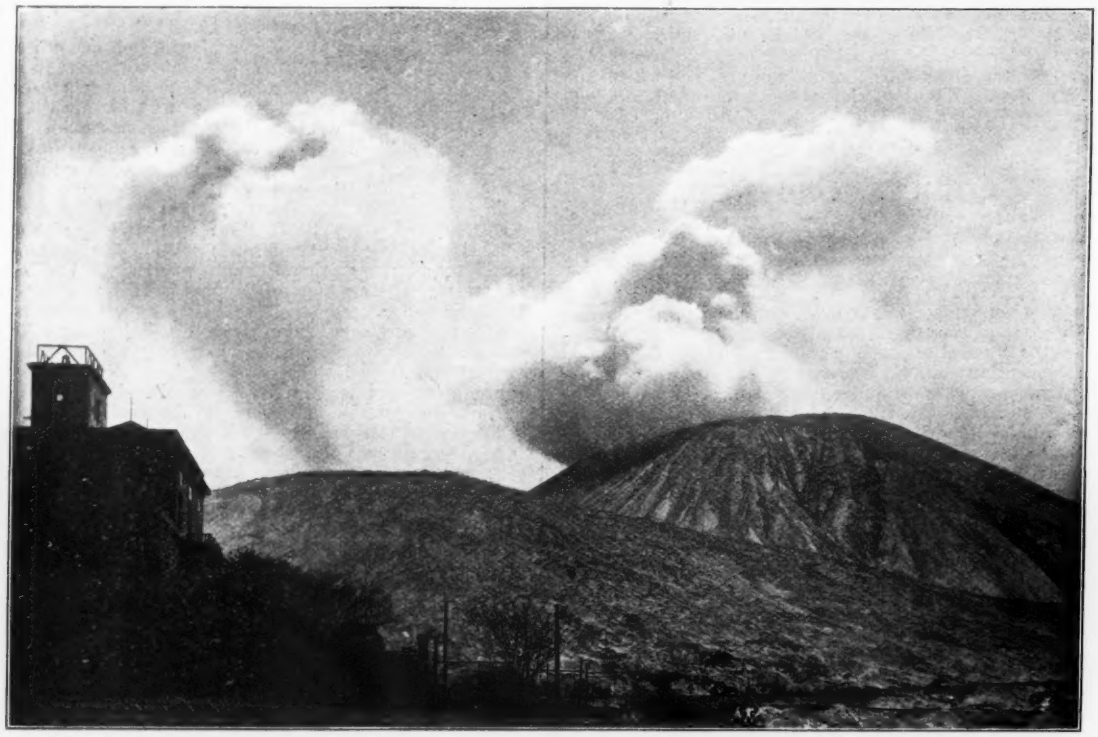
The Eruption of Vesuvius.

By the courtesy of Dr. Tempest Anderson, of York, the well-known vulcanologist, we are enabled to reproduce a photograph of a stage of the recent eruption of Vesuvius, taken by himself, on April 26 last. The Observatory is to the left of the picture. In the centre is the cone of the eruption of 1898, now known as the Colle Umberto I°, while the cone of Vesuvius in the distance shows the tracks of ash-slides.

The top of the cone of Vesuvius before the recent outburst was situated at a height of 1330 metres, or 4,400 feet, and aneroid measurements, averaged with those taken by Mr. Perrett, of the Observatory, showed a loss of at least 350 feet.



Vesuvius—the Observatory from the Fossa Vetrana.



The recent eruption of Vesuvius (late stage).

The small figure is a photograph, taken during the eruption of 1898, showing Dr. Matteucci's Observatory, with lava in the foreground. The hill on which the Observatory is situated forms part of the great crater ring of Somma, but is separated from that part of the mountain by the valley, Fossa Vetrana. Vesuvius is to the left, out of the picture. The picture shows that the Observatory is secure from damage by any ordinary eruption.

It should be added that these photographs formed part of the lantern demonstration given by Dr. Anderson at the Royal Society's *soirée* on June 19.

Telephones and the American Accent.

IT is said that the general use of the telephone in the United States of America is destroying the distinctive Southern intonation, and that the American accent is tending to become uniform all over the country. This is because the use of the telephone is bringing all normal voices to a sameness of pitch, and is engrafting a similarity of enunciation. That must especially be the case in long-distance conversations, because the talker has to exert a conscious effort in clearness and distinctness of enunciation. It is possible that from allied causes the character of spoken English might as a whole become changed. English is called by foreigners the hissing language, because of the predominance of the "s."

The Study of the Cell in the Higher Plants.

By H. A. HAIG.

THERE are few things more interesting in the science of botany than an insight into the ultimate structure and vital processes presented by the cell; and in this article I shall endeavour to make clear some of the more important functions and structural details to be made out in those cells which are met with in the more highly differentiated members of the vegetable kingdom. It is, however, to be borne in mind that living cell-units may in all cases be reduced to one or more simple types, and that there is no essential difference in function between a cell from the assimilating tissue of the cortex in a higher plant, and that from a filament of an Alga, although there may be some difference in structure, in order to cope with surrounding conditions.

It will, perhaps, be well, first of all, to state concisely what we have to examine in any given cell, in order, and then to take each one of these and study it separately; and, finally, to sum up the attributes of the cell, and from this to try and gain some idea of the general value of the organism considered as a co-worker with others of the same kind.

In any given cell we shall have to study:—

1.—The general microscopical structure.

2.—The reaction of the cell to stimuli of various kinds.

3.—The reproduction of similar cells from pre-existing ones.

4.—The further modification of a cell as dependent upon its position and the functions it has ultimately to fulfil.

Further, I shall endeavour to compare the results of our observations with those arrived at by some of those biologists who have made the cell their special study. [Of the figures that illustrate the text, some are drawn from actual observation, and others are photo-micrographs. The methods of staining and preparation will not be gone into very fully, as space does not allow.]

1.—The general microscopical structure.

A cell from a growing-point, such as a stem apex or root-tip, serves very well for the study of structure in very young cells.

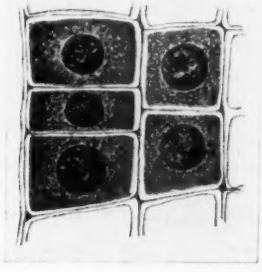


Fig. 1.

We have (see Fig. 1) an obvious cell-wall, and contained within this the protoplasm; about the centre of this latter is situated the nucleus, which is circular in outline and in general shape spheroidal. In these very young cells, the protoplasm appears to fill the whole cavity. It has a granular appearance, and these granules are possibly either protoplasmic in nature (microsomata) or food-particles, but the latter is doubtful, as most food-materials exist in the cell in a state of solution, except when they are in the form of reserve-materials.

These main features are seen if we make thin longitudinal sections of the given tissue, which must be stained (preferably with logwood), and properly mounted either in Canada balsam or glycerine.

There have been many assumptions made as to the ultimate structure and chemical composition of protoplasm, amongst these being Nägeli's micellar theory and the framework theory of Klein, Leydig, and others; but the one that appears to account best for the various physical properties of protoplasm is that due to Bütschli, the foam or honeycomb theory, although even to this there are objections.

There seems to have been a tendency recently to advocate this latter theory, on account of various sur-

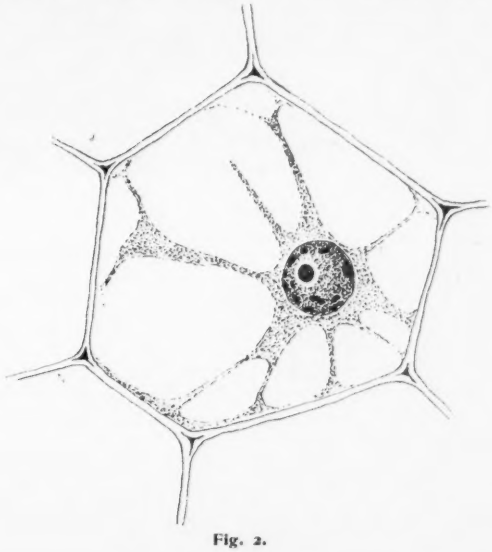


Fig. 2.

face-tension phenomena exhibited by emulsions, and certainly the appearances presented by protoplasm are in some cases very similar to these. But, whilst admitting the value of these observations, it is certain that they do not wholly unravel the physical structure of protoplasm.

If we examine somewhat older cells, that is, cells which have been carrying on their vital functions for some little time, it will be seen that the protoplasm no longer entirely fills the cell, but is thrown into "bridles" or strands passing from a larger central mass, which usually contains the nucleus, to the cell-wall on all sides (see Fig. 2). The spaces not occupied by protoplasm are usually filled with fluid, the cell-sap, and this contains some of the nutrient materials for the cell. The strands of protoplasm, as well as the central portion, are still granular, and in some cases it is possible to demonstrate fibrils passing between adjacent cells, the so-called "intercommunicating fibrils" (see Fig. 3). These are well seen in the cells of the young endosperm of Caltha palustris, and their importance we shall enlarge upon later. A well-known example of them exists in the communicating threads

between adjacent sieve-tubes in the phloëm of the vascular system of higher plants.

The cell, as it gets still older, enlarges continually up to a certain point, but the protoplasm does not increase in volume proportionately, so that ultimately we have a central "vacuole" filled with cell-sap, and outside this, lining the inner surface of the cell-wall, is a

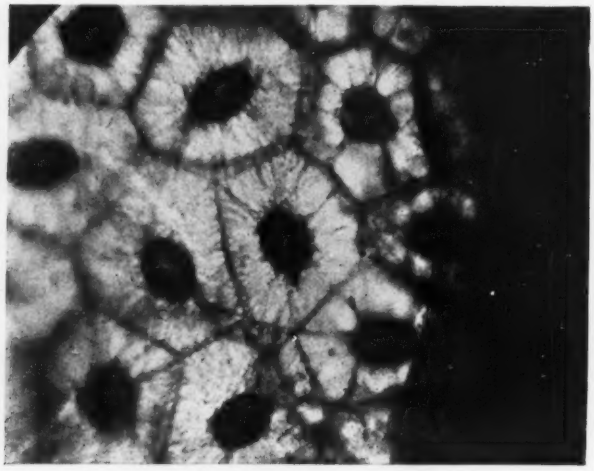


Fig. 3.

thin layer of protoplasm, in which is somewhere enclosed the nucleus.

This peripheral layer was first described by von Mohl as the "primordial utricle." It has a very important function, which we shall discuss further on.

The nucleus is a most important structure; as usually seen, it is a clear, rounded body, with a more or less

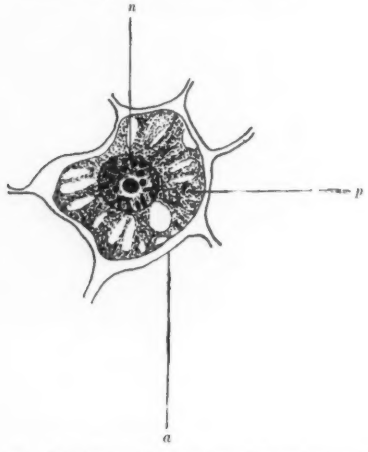


Fig. 4.—Young Cell from pith of stem of Lupulus. *a*. Cell-wall. *p*. Protoplasm (Endoplasm). *n*. Nucleus, showing nucleolus and chromosomes.

central dot, the nucleolus, in its interior. When carefully stained with logwood, it is seen to have a definite structure, the most frequent being a punctate or reticulate appearance, which about the time of nuclear division becomes very marked indeed (see Fig. 4).

Numerous observers have described a membrane, the "nuclear membrane," as the external contour of the nucleus, and the nucleolus, of which there may be more than one, also seems to have a vesicular structure. But more recently, it has been thought that the nucleus is a rounded space in the protoplasm, the margin of which is formed of firmer protoplasm (altered kinoplasm)* than the main mass.

With high powers of the microscope, and very careful preparation, it has been shown that two bodies, the "centrospheres" or "blepharoplasts" exist in the protoplasm very close to the nucleus. They are of importance in nuclear division (mitosis); but they probably do not exist as formed structures in the cells of plants higher than the Liverworts.

There are certain other structures present in the general protoplasm of a cell; these are the "plastids" or "chromoplasts," the former term being the best, as they do not always contain pigment. They are, like the nucleus, specialised portions of the protoplasm, and function as a rule in the manufacture of starch. Very often they may be seen grouped round the nucleus, but as yet the significance of this has not been explained. It is probable, however, that during active division, the nucleus requires a large supply of carbohydrate food, and in this case the nearer the plastids are the better. The chlorophyll granules so often seen in the cells of the green assimilating tissues are only plastids containing the pigment chlorophyll, and are here, of course, true chromoplasts.

A word or two requires to be said about the grouping of cells into tissues. A cell equally pressed upon all sides by other cells usually assumes the form of a regular dodecahedron, that is, on section, the figure is a hexagon. If the pressure is not even all round, then certain deviations from this natural rule exist, and we get on section four, five, seven, etc., sided figures. The rectangular prism is also a common form assumed by cells in cortical regions, where definite limited layers of cells exist, and the radial and vertical pressures are as a rule unequal. The natural form of the hexagon is seen well in the young pith of certain plants (Sambucus).

Although the shape of the cells in any tissue is thus to a large extent determined by external physical causes, the growth of the cell, as a whole, is brought about by the agency of the protoplasm, which takes in the various food-materials and transforms them into other substances, which form integral parts of the body of the cell.

We have now briefly examined the general features of the living cell microscopically, and have seen that it consists of several parts. Each of these parts has a definite function of its own, and the living portions of the cell, *i.e.*, protoplasm, nucleus, and plastids, are intimately related to one another in a way that we shall presently see. It is instructive to look upon the cell as a transformer of energy, and as a utiliser of the same, but it is only a limited view of the total function of the organism, for, as we shall see, there exists a mutual interdependence between the different living cells of any plant.†

2.—The reaction of the cell to stimuli of various kinds.

We have spoken of a cell as a living unit, and we have now to enquire into the manner in which the protoplasm responds to, in the first place, nutrition, and,

* The "kinoplasm" is that portion of the general protoplasm which lies just outside the nucleus; it is not so granular as the main mass.

† This view is well discussed in Kerner's Natural History of Plants, Vol. 1, Pt. 1.

in the second, to the various external forces that are brought to bear upon it. The fact that in some cells, notably those of hairs from the stamina of Tradescantia, the protoplasm has the power of movement, that is, is carried round the cell in varying directions, and that this movement depends upon a number of conditions, such as temperature, a requisite supply of oxygen, and some others, shows that this substance is "irritable," or, in other words, has the property of responding to stimuli.

An interesting fact is the observation that root-hairs, which are very elongated, delicate cells, can exert a certain power of selection when surrounded by a solution of various salts (a nutrient solution so-called) and this shows that the peripheral protoplasm of these cells is more irritable to certain forms of chemical stimuli than to others. Likewise the experiments upon masses of naked protoplasm, although here we are more rightly considering the cells of higher plants, show that it is directly irritable to other forms of energy, such as light and electricity. These experiments are to us useful, from the point of view of comparison, for, all things considered,. the main difference is that in the case of cells of higher plants, which we are considering, a cell-wall exists, which in some way modifies the action of the stimuli.

We have called attention a little further back to certain intercellular communicating fibrils of protoplasm. These fibrils have been thought to be of use in the conduction of stimuli from any given cell to adjacent cells, and so on to those more remote. There is some evidence to show that this communication by fibrils is of value to a plant much in the way that so-called "trophic nerves" are to an animal with a well-marked nervous system, for cells that have been partially injured may revive if still in communication with other cells. But more proof is required before this can be definitely settled. One thing is, however, certain, namely, that nowadays one would no more think of calling a living cell an isolated unit than say that the cortical cells of the brain are functionally isolated portions of the central nervous system.

We must not, however, look upon the main mass of protoplasm in a cell as the only irritable part; the nucleus, the plastids, and, at certain times also, the centrospheres are influenced by stimuli reaching them either directly or from adjacent cells, for, as we have seen, these structures are one and all specialised portions of protoplasm. The plastids, however, are mainly irritable to certain chemical stimuli, produced chiefly by carbohydrates in solution, and, in the case of the chloroplasts, the pigment chlorophyll sifts out certain portions of the radiant energy reaching them from the outside and, co-operating with the chemical stimulus, so acts upon the protoplasm of the plastid that this latter is enabled to form starch. There is evidence for believing that the actual protoplasm of the chloroplast becomes transformed into starch, and, moreover, it has been shown that proteids can, as a rule, be split up into nitrogenous and carbohydrate portions, so that the transformation in the plastid is not so astonishing as at first sight appears. The same thing probably occurs during the formation of the cell-plate in indirect or mitotic cell-division.

The protoplasm responds to nutrition by (*a*) growth of its substance, and (*b*) growth of the whole cell. Assimilation is, however, the result of a number of stimuli, some chemical, produced by the various food-materials, others physical and depending upon light and temperature. It is the combination of these and a certain unexplainable (as yet) vital activity* which constitute metabolism, a term which includes both the building up and breaking down processes essential to the life of the protoplasm.

There are certain factors in the response of protoplasm to stimuli which must be present in order that such a response may be called out. These are, the presence of oxygen and a good supply of water, in which latter the oxygen is usually held in solution to a small extent. The existence of free oxygen in a cell enables the katabolic side of metabolism to be carried on, and the process is certainly as essential to the life of the cell in plants as it is to the animal cell. Water, on the other hand, is equally essential, for the protoplasm is largely composed of water, both chemically and physically speaking, and in the transport of materials from cell to cell it is of the highest importance.

These two substances, then, oxygen and water, being present, the protoplasm is in a condition to utilise and react to the various forms of energy which reach the cell from the outside, and the result is that the organism is enabled to carry on a number of processes, both physical and chemical, and in so doing, increase in volume, change in shape, and the production of other cells are brought about. That protoplasm has a directive action is evident from the fact that certain organs grow in different directions, but after all, this directive action is the result of the reaction of protoplasm to certain external stimuli, such as gravity (geotropism) of moisture (hydrotopism). The action of gravity in causing a root-tip to bend downwards is well established by experiment, and the discovery that a force in any direction (centripetal force) could replace gravity, has shown that it is really the given force which has influenced the directive action of the protoplasm of the individual cells. The true nature of this action is as yet obscure, but there are grounds for assuming that an attractive force, such as those we have taken as instances, in some way modifies the intensity of metabolism so as to cause greater rapidity of growth in those portions of a cell which are furthest from the attraction.

The fact that certain flowers will turn towards or away from light is another well-known instance of the reaction of protoplasm to external stimuli, and on the whole is due to the same cause, namely, increased growth on that side which is turned away from the stimulus. It is a well ascertained fact that more rapid growth takes place in darkness, when transpiration is at a minimum, than in the light, and the phenomenon of heliotropism is thus not astonishing, as those portions of a plant which are directed towards the most intense illumination should transpire most, and grow least rapidly, whereas in those parts turned away from the light the reverse should be the case. But although these observations serve as a gross explanation, they do not show us the true reason for the increased activity of the protoplasm. It is true that transpiring cells are in general less turgid than non-transpiring ones, and turgidity favours growth, so that here we may have a partial explanation.

Turning now to that point to which we directed attention some little way back, namely, that a living cell must not only be looked upon as an individual

* There appears to be some doubt as to the legitimacy of the use of the term "vital-activity." See Huxley on "The Physical Basis of Life," in "Method and Results."

XUM

unit capable of working for itself, but also as being dependent upon others by reason of interprotoplasmic connections, we have several instances of the value of this conception, especially with regard to certain movements that are produced by tactile stimuli in plants such as the Sundew and Mimosa. In the former, contact of a small foreign body (preferably of an organic nature) with the glandular outgrowths on the upper surfaces of the leaves leads to a bending over of these outgrowths (hairs) so as finally to enclose the irritating substance. It has been shown that here the stimulus passes most probably by certain living elements of the central tissue of the excrescence, and that this stimulus finally influences cells at the base of the hair, which in turn alter their turgidity on one side of the hair more than on the other. It is, however, to the protoplasm that the effect is ultimately due, and it is upon this substance that the stimulus has effect. A similar result may be observed in the leaves of the Mimosa pudica, where a tactile stimulus, the rate of travel of which can be measured, produces a depression of, first, the leaflets and then the whole leaf, consequent on diminished turgidity in the cells of the pulvini situated at the base of the petioles.

In some of the lower plants, Spirogyra, for instance, it has been found possible, by suitably altering the surrounding conditions, to substitute amitotic for mitotic division; and it is to be assumed that in higher plants, mitosis has arisen in order to cope with altered conditions of existence, for we shall see that economy is of the highest importance to the cell-community, and mitosis affords an almost exactly equal distribution of nuclear substance in each of the two daughter nuclei. Moreover, in the higher plants, it is probably a very fixed and constant method of division, not readily changed to the amitotic form; and we shall here study mitosis as it occurs in the Gymosperms and Angiosperms. [In the following figures, the centrospheres have been omitted, as the methods of preparation of the sections were inadequate to show them, even assuming that they were present at all.]

In order to follow the karyokinetic changes properly, it is necessary to study, first of all, the minute structure of the resting nucleus. This body, as we have seen, is supposed by some to possess a definite nuclear membrane, which encloses at least three different portions, named respectively, nuclear plasm, nuclear network, and nucleoli. The network is composed of a

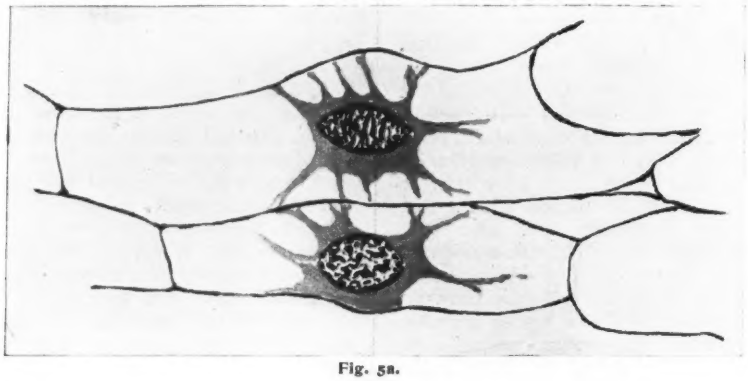


Fig. 5a.

We have now briefly considered the effect of some of the commoner stimuli upon the protoplasm. The manner in which the latter responds is not the same in all cases, and in some parts of a plant a given stimulus might produce an effect which it would not call forth in a more remote part, and *vice versâ*. There is, however, a certain "specific irritability" inherent in the protoplasm of various parts of a plant which enables it to make use of one or perhaps several stimuli in excess of all others, but what this is due to is not known. Perhaps heredity has some value in the explanation of this curious, yet undeniable fact; and we shall see later the effect of "position" upon the cells of any part of a plant.

3.—The reproduction of similar cells from pre-existing ones.

In the higher plants, cell-division is always preceded by nuclear-division, or karyokinesis; in some instances, however, the formation of definite cell-walls does not immediately follow division of the nucleus, notably in the process known as free cell-formation, where a large number of nuclei are first formed, lying free in a shell of peripheral protoplasm in the embryo-sac.

In a few cases, the nucleus is capable of "amitotic" division, that is, simple fission into two more or less equal portions, but in this case, no fresh cells are formed, and the nuclei simply increase in number.

substance known as linin, which is, according to various observers, unstainable by logwood, and on the meshes of this network are situated at certain points, small masses of a substance known chemically as nuclein, or chromatin, which stains deeply with logwood, and the more so the nearer the time for division approaches. The nucleoli (one or more, as the case may be) form well-marked masses at certain points of the network, but are usually quite distinct from this latter; they stain with logwood, but show some differences when the nuclei are treated with a compound stain, so that nucleoli are stained differently to the other nuclear structures.

If centrospheres are present, they will be seen close to the nucleus, in the surrounding protoplasm (kinoplasm); but it is not at all certain whether these bodies are present near the resting nucleus or whether they are rather to be looked upon as originating from a nuclear structure about the time that karyokinesis is about to start. If we examine a longitudinal section of a rapidly growing root-tip, in which the nuclei are of a good size (hyacinth roots serve excellently), and in which the various staining processes and subsequent preparation have been carefully carried out, we shall find instances in different cells of all stages in mitosis. The earlier stages are easily made out from the very different staining reaction shown by the masses of

chromatin, which appear of various shapes, and more or less separated from each other, as in a resting nucleus. This is the stage of preparation, and in very careful preparations it is possible to make out the existence near the nucleus of a peculiar body, the "nuclear spindle," as yet quite small, but subsequently attaining a much larger size. The spindle is said to be formed from the kinoplasm, but all observers do not agree on this point. The first stage (without the spindle) is shown in Fig. 5a, which shows two nuclei, one of which is in the first or preparatory stage, the

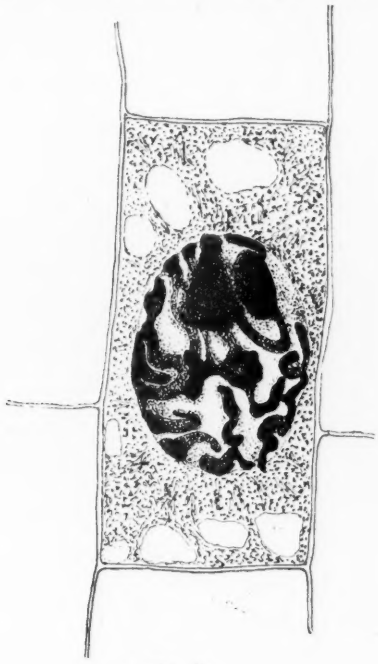


Fig. 5b.

other (more spindle-shaped) one being in the second or spirem stage. The other part of the figure shows an early spirem.

In the following stage, the masses of chromatin seem to join up into one long thread, which has the appearance of a skein, and hence known as the "spirem" phase (see Fig. 5a). The poles of the nuclear spindle have travelled further apart, and if centrospheres are present, they are seen one at each pole. Since the separate threads of which the spindle is composed do not stain with chromatin staining dyes, it is further known as the "achromatic spindle."

Fig. 5b shows a nucleus in a preparatory stage.

(To be continued.)

REVIEWS OF BOOKS.

ASTRONOMY.

Astronomy in the Old Testament, by G. Schiaparelli. Authorised English translation. (Clarendon Press, Oxford; 3s. 6d. net.)—This is a disappointing book, disappointing not so much for the manner in which it is written, but in that the investigation gone into is so barren of results. It might be expected that there would be numerous allusions in the Old Testament to astronomical phenomena, which might bear explanation, and be of the highest interest. But very few are here described. Again and again we are told that such and such a statement *apparently* refers to such and such an astronomical event. But there is no certainty all through; all is conjecture, and most of the quotations are practically unexplainable. And the book even tends to some confusion; in one part it is stated: "We are led to the important conclusion that . . . the Hebrews had some knowledge of the seven planets," and yet in another part, "Of the planets considered singly, two only can be traced in the Old Testament." Though of but negative interest, the book should prove of great use to those who wish to investigate this subject. It would have been the better for an index.

Giant Sun and His Family, by Mary Proctor (Silver, Burdett and Co., New York, Boston, and Chicago, 1906; pp. viii. + 167, with frontispiece and illustrations).—Without displaying the facility and erudition of her celebrated father, the authoress of the present work has succeeded in producing a volume of great interest to young readers. It is professedly an epitome of a series of lectures, and as such is not free from some of the drawbacks associated with a work of that kind, especially in regard to the balance of the different parts of the subject, the three eclipses actually witnessed by the writer being allotted needlessly large space, with repeated detail from nearly parallel accounts, considering that space had also to be found for much other solar work, besides the chapters on the many members of the "Giant's" family. As a book for children, its primary object, the volume should find a ready welcome; but as a text-book, it is not beyond reproach. Apparently the writer's desire to avoid even such a harmless technical term as "section" may be held responsible for the ambiguous statement that the moon's shadow is "of the same general shape as itself, that of a *long, narrow cone.*" We might also allege looseness of expression, if not inaccuracy, against the remark that Halley and Encke discovered the comets that bear their respective names. The illustrations are nearly all good, though the lunar landscape which forms the frontispiece may not be convincing.

Modern Cosmogonies, by Agnes M. Clerke (London: A. and C. Black, 1905; pp. vii. + 287; 3s. 6d. net).—Most of this work should be familiar to the readers of "KNOWLEDGE," thirteen of the sixteen chapters having already appeared in its pages—some before and some after the change in the title of the magazine. Miss Clerke's well-known literary style, with its fertile command of language and facility of luminous expression, is beyond criticism. Any reader of her other works will be prepared by the very title of the one before us to find her revelling in word-pictures of the sublime speculations of philosophers and scientists as to the origin, progress, and destiny of the universe, a subject of sufficient scope for the most ardent inquirer. From Thales to the new Satellites of 1905, though naturally in a work on Modern Cosmogonies only one chapter can be spared for the predecessors of Kant, hardly a single worker who has really added anything, however small, to the subject, goes without recognition by Miss Clerke, whose instinct may perhaps at times see more in such contributions than their originator probably contemplated, and accordingly do him more than justice. A great subject treated in a masterly manner, and, withal, a very readable book. But the last word on Cosmogony is not yet written, and we imagine it will not be long before new quantitative investigations of tidal friction, new refinements of spectroscopy, or new speculations as to ether, protyle, or the genesis of organisms may be demanding new editions, revised and enlarged, which we hope the gifted authoress may long be spared to provide.

BOTANY.

A Revised Key of the Hepatics of the British Islands, by Symers M. Macvicar (Eastbourne: V. T. Sumfield; 9d. post free.)—This appears to be mainly written for the use of beginners, to whom it will be of service in ascertaining the name of a plant, which can afterwards be verified, and fuller details obtained from a more advanced text-book. Some useful information is given in the preface, as to the points to be noted in the examination of a specimen.

XUM

CHEMISTRY.

Joseph Priestley, by T. E. Thorpe, F.R.S.; pp. ix and 228. English Men of Science Series (Dent and Co.)—The work of the chemist does not "touch life," to use an Americanism, at many points, and so the world has not had its interest awakened in the lives of many of those who helped to build up chemistry into a science. Thus, if you ask an average Englishman what he knows about Priestley, he will probably tell you that he had something to do with the discovery of gases, and that his house was burned in the riot at Birmingham; but of the man himself, or of his surroundings, he will know nothing. We, therefore, owe a debt to Dr. Thorpe for giving us in an accessible and very readable form a life of Priestley which, though of necessity too brief, yet brings the man and his time vividly before us. The account, which is to a large extent based on autobiographical notes, gives us incidentally a succession of pictures of middle-class life in the latter half of the 18th century. We follow Priestley through his boyhood among the handloom weavers in Yorkshire, his training for the dissenting ministry, his struggles as a minister, "passing rich on forty pounds a year" (a large amount of which he did not get), his more successful venture as a private schoolmaster, and his appointment in the Warrington Academy, where his scientific career may be said to have begun. Then come his marriage, his association with Lord Shelburne, his life in Birmingham, where he became a prominent member of the Lunar Society, the violent attacks made upon him from all sides at the height of his scientific career, on account of his supposed sympathy with the French revolutionists, his virtual banishment from England, and his settling and death in America. Dr. Thorpe has dealt with all these chapters of Priestley's life concisely, but yet sympathetically, and with sufficient detail to give a clear idea of the man, strong, and ever struggling against circumstances to express what he believed to be the truth, both in religion and in science. The last chapter, dealing with the chemical work of Priestley, is, perhaps, somewhat too abstruse for the general reader, but it will be read with the greatest interest by the chemist, for Dr. Thorpe brings out clearly how often Priestley was on the very verge of great discoveries, which he missed solely through his reluctance to part with the old doctrine of *phlogiston*. As Dr. Thorpe remarks: "Priestley was in fact a pioneer; he showed the existence of a new world for science, and he himself roamed over a portion of it, like a second Joshua; but he had not the experience or the aptitude to map out accurately even that fraction."

Chemistry Lecture Notes, by G. E. Welch, B.Sc. (London: Blackie and Son; pp. 63, 1s. 6d.)—The notes given in this little book are such as should be taken by students working at stage II. of Inorganic Chemistry. They are clear and concise, and should be of use in going over the ground before an examination. Yet, in spite of the author's remark in the preface, that "Much valuable time is wasted in note-taking," we cannot help thinking that the stained notes of the student, written down in his own words at the time of the experiment, are of infinitely more value as a training in chemistry than mastering these model notes, which he can assimilate for examination purposes and then forget.

GEOMETRY.

Geometry, Theoretical and Practical, by W. P. Workman, M.A., B.Sc., and A. G. Cracknell, M.A., B.Sc., F.C.P., price 3s. 6d. If the University Tutorial Press is guilty of producing a further addition to the already overflowing list of "Geometries" recently brought out "to meet modern requirements," it cannot be said that the addition is in any way unjustifiable. Since the bygone days, when a small circle of authors commenced to write books for the then new and practically unknown series, a noticeable feature of these books has been the absence of mere repetition of methods, good, bad and indifferent, contained in previous text-books, and those who are behind the scenes know that in many instances, the improvements which have seen the light in these books have only been effected by considerable expenditure of time and money. The new Geometry contains abundant evidence that the authors have succeeded in impressing their own individuality on even this well-worn subject by the introduction of many desirable and novel features; indeed, under the circumstances, the book strikes us as one of noticeable originality. It commences with an introductory course in constructive Geometry not only of plane figures, but of the simple solids, and throughout the remainder of the book a careful balance has been maintained between theoretical deductions, constructive exercises, exercises solved by calculation, and riders. We do not altogether agree with the arguments for abolishing Euclid contained in the preface, and we believe that the real facts of the case are but little understood. So far as order of treatment, and so forth, is concerned, the Geometry of the present day is not new; the "Text Book of Science," by Watson, published considerably over a quarter of a century ago, being identical with it even in many such points of detail as the admission of "hypothetical constructions." But if Watson had lived in the time of Euclid and Euclid had lived in the time of Watson, a change from "Watsonian" to "Euclidian" methods might equally well have been heralded as a reform. Where the real improvement comes in is in furnishing Geometry with "examples," similar in point of relative difficulty to the examples by which beginners learn arithmetic and algebra. It is remarkable that while, as the authors say, "the Euclidian methods of the year 1900 represented the accumulated experience of many generations of competent teachers," these teachers had never devised any plan of teaching otherwise than by making their pupils either learn up the propositions or putting them on to solve hard riders which many of them never could solve, and which the teacher himself had in most cases to solve for them. The introduction of the ruler, compasses, and protractor has now supplied beginners with plenty of examples which they can work out for themselves, and learn something in working them. We are glad to see that the chapter on loci contains an exercise on plotting an ellipse, and that in connection with "hypothetical constructions" the reader is warned against the mistake, of which "join O to P bisecting the angle A O B" is a common instance.

NATURAL HISTORY.

Recreations of a Naturalist. By J. E. Harting. (London: T. Fisher Unwin, 1906, pp. xvi. + 233, illustrated; price 15s. net).—Mr. Harting is such an old favourite with the nature-loving public that any work from his pen is almost sure of a favourable reception. He has, moreover, the advantage of being not only a first-rate field naturalist, but likewise an ardent sportsman, and also, to some extent, an antiquarian, having a very large acquaintance with early English and foreign literature. He, therefore, appeals to a much wider field than that with which the majority of writers on popular natural history are obliged to be content. The articles in the volume before us have already appeared in the *Field* (without, in most instances, the illustrations, which add to their attractiveness), and the author has accordingly had the opportunity of revising his views when necessary. They cover such a wide range of subjects as hawking, grouse and black-cock shooting, distribution of partridges, origin of the cat, sheep-dog trials, bird life on the Norfolk Broads, swan-upping on the Thames, and the oldest work on angling. To be an expert on such a diversity of subjects alone proclaims great capacity and industry, and if the author is a little less up-to-date in some of the articles, such as the one on the ancestry of the cat, he may well be excused. We have read the book with pleasure, and can heartily commend it to our subscribers.

PHOTOGRAPHY.

Successful Negative Making, by T. Thorne Baker, F.C.S., F.R.P.S. (London: Marshall, Brookes and Chalkley, Ltd.; price 6d.)—This, the first of the "Focus Photographic Manuals," is a small volume of forty-one pages divided into five chapters, dealing with the plate, exposure, development, fixing, washing, intensification, and reduction. Some of the statements in the book are not orthodox, as, for example, that a colour screen is less needed when the colours are brilliant and "rich" than where there is a great deal of reflected white light, and that, in general, the colour screen or filter must be suited to the view; that "for lantern slide making one wants really harsh negatives to get the best

results;" that in intensification, "during re-blackening the silver mercurous compound formed in the bleaching is reduced to metal," while the very first blackening formula given has not this effect; that "the smaller the stop, the finer will be the detail, the more vigorous the negative, and the greater the latitude in exposure;" and so on. Notwithstanding such statements, the manual will be found useful by beginners, and the three illustrations showing the same subject as taken on a slow, a medium, and a rapid plate will be a welcome guide to many in their choice of plates.

Photographic Enamels. From the French of René D'Héliécourt (London: Iliffe and Sons, Limited, 1905; price 2s. 6d. net).—The production of enamels is a branch, or rather perhaps an application, of photography that is hardly referred to in general text-books, for the sufficient reason that it is only an exceedingly small proportion of those who are interested in photography that care to trouble themselves about it. But the making of photo-enamels has had a measure of commercial importance for a generation or more, and is an art that deserves more patronage than it receives. It is, moreover, a very interesting subject for an amateur to work at, especially if he has had any experience in chemical operations, and the manipulation of furnaces. We therefore welcome this translation of that part of M. René D'Héliécourt's "La Photographic Vitrifiée" that refers definitely to this subject. The instructions given are clear and concise, and are not confined to one method, but satisfactorily cover the subject. It is essentially a practical guide, and will be much appreciated by those who wish to experiment in this direction.

PHYSICS.

Physical Optics, by R. W. Wood (Macmillan and Co.; 15s. net). This is in many respects a notable book, in so much as it may be considered supplementary to previously existing text-books. In Preston's "Theory of Light" the most modern developments are practically ignored, and although the gap is in part filled by more recent text-books, there was great need of one which should deal adequately with the experimental as well as the theoretic side of the subject. Special stress has been laid on this in the present volume, and all who have followed the numerous publications of Professor Wood during the last ten years will cordially recognise that no one could have been found with a better equipment for the work. Some may regret that the theoretic side is sometimes rather cramped; we advisedly used the word "supplementary" above. The reader may often require to turn to other sources for further information. The aim of the author has been chiefly to supply what cannot be found elsewhere in collected form. The treatment of the subject is eminently original. For a book of its standard, it is unusually full of numerical illustrations of theory. This will be found of great help to a private student. The experiments, specially devised by Professor Wood, are often of a very simple character, which an amateur may carry out. Special stress is laid on dispersion, absorption, the optical properties of metals, fluorescence and phosphorescence, the nature of white light, the relative motion of the ether and matter. The explanations are based mainly upon the electromagnetic theory. There are a large number of figures in the text; and very many of these have a very fresh appearance. We notice a few mistakes; the author repeats a common error in asserting that all the secondary maxima of a diffraction grating are given by the equation, $n \tan z = \tan nz$; it has fairly recently been pointed out that when n is odd, one such maximum fails to be included in this set. The proper expression, which includes all, is $n \cot nz = \cot z$. The figure (Fig. 144) which shows the graphical solution of the insufficient equation is wrong in showing a solution at $\pi/2$; such a solution does not exist. There are other misleading statements in the same section. The book, however, is wonderfully free from errors of all kinds, and it will doubtless at once take a leading place as a text-book for senior students.

MISCELLANEOUS.

"Science Progress." — Science Progress in the Twentieth Century. A quarterly journal of scientific thought. No. 1, July, 1906. (John Murray, 5s. net).—After some years of discontinuance the courageous attempt to present periodically a competent review of current scientific work for scientific readers has been revived under its old title of *Science Progress*. The attempt was courageous formerly, and it failed from a want of support among scientific people who are, perhaps, too prone to become immersed in their own special subjects and to neglect and lose touch with progress in other branches of science. But the attempt is no less courageous now, because while science tends more and more to specialisation, the public or popular interest in science—perhaps owing to the fact of specialisation in science—grows less and less. In the so-called dead sciences specialisation and mathematics are lifting their details far above the heads of the public, and in the "natural" sciences cycling and the camera have diverted popular attention from more sedate pursuits and from the quiet observation of Nature. None the less, we hope and believe that *Science Progress* in its new garb and condition will find a public of its own, as it well deserves to do. Great Britain, despite the scientific ignorance of the great mass of its people, and despite the natural unwillingness to spend money on scientific literature, is very well served by its scientific periodicals, two of which will compare with the publications of any other country. But it needed a more solid review, a kind of *Nineteenth Century and After* of science; and we sincerely hope that *Science Progress* will prove the real scientific quarterly. It makes an excellent start in its first number with articles, among others, by Dr. B. J. Collingwood on "Chloroform a Poison"; by Mr. A. D. Hall on "The Solvent Action of Roots on the Soil Particles"; by Mr. F. V. Theobald on "Injurious Insects"; and articles on "Chemical and Structural Crystallography," by Mr. A. E. H. Tutton; on "The Geological Plans of Some Australian Mining-Fields," by Mr. J. W. Gregory, F.R.S.; on "The Corn Smuts and Their Propagation," by Dr. T. Johnson; and on "Nehemiah Grew and the Study of Plant Anatomy," by Dr. Agnes Robertson.

Vivisection; Doubtfully Useful and Certainly Wrong, by J. P. Hopps. (London: Henderson, 1906, 42 pp.; price 6s. 6d.).—The author of this pamphlet may be congratulated on the thoroughly temperate and fair manner in which he has argued the case against vivisection. In many respects, especially as regards prohibition of vivisection without anæsthetics, we are disposed to agree with his views; although we may be permitted to doubt whether he has demonstrated that vivisection is useless. One point he seems to have missed, namely, that vivisection might perfectly well be prohibited altogether for a period, till some special new subject requires investigation. That the practice ought to be abolished when employed merely for purposes of demonstration we are convinced.

Ethics, by C. W. Saleeby, M.D. (Jack's Scientific Series; price 1s.)—This forms an excellent little treatise on that abstruse subject, Ethics, and the connections between morality and religion. Some of the most interesting chapters are those on "The Object of Life," "Egoism and Altruism," and the "Worship of Truth." There is much to ponder over on reading this book, and as it only fills 115 small pages, it is not too tediously long, as is the case with many other works of the kind.

"Spiritualism," by Edward T. Bennett, is one of Jack's Scientific Series (1s. net).—Both believers and non-believers cannot fail to be highly impressed with the many uncanny stories here told. Mr. Bennett was assistant secretary to the Society for Psychical Research, and, therefore, is in a good position to obtain all the best and most reliable accounts of the strange things that have happened in investigating this subject. And he, very rightly, takes care to repeat only statements of facts which are thoroughly well authenticated. Accounts of movements of objects, production of sounds, and appearance of light without any apparent physical cause, form the chief part of the contents of the book, while chapters are also included on The Divining Rod, Thought-Transference Drawings, Materialisations, and other matters.

The Engineer's Pocket Dictionary, French-English, by M. Lvoff (Percival Marshall, 1s. 6d. net), is a most handy and neatly got-up list of technical words in French, with the English equivalent.

XUM

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, B.A., F.R.M.S.

Royal Microscopical Society.

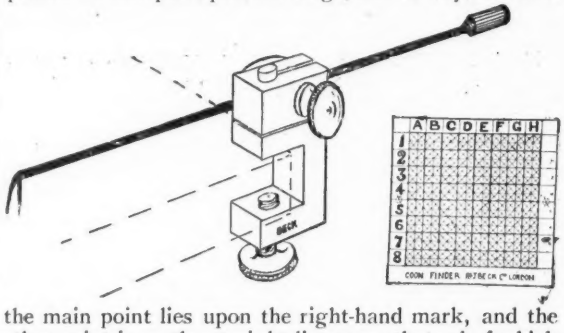
JUNE 20, Dr. Dukinfield H. Scott, F.R.S., President, in the chair. Mr. J. T. Holder exhibited and described an old microscope made by Andrew Pritchard in 1846, which had been lent for exhibition by Mr. W. R. Reeves, of Liverpool. Dr. Hebb exhibited some high-power stereo-photo-micrographs of diatoms at magnifications of 500 to 2,000 diameters, received from Mr. Dollman, of Adelaide, South Australia. The President read a paper on "The Structure of some Carboniferous Ferns." He pointed out the change which had taken place in the last three years in our conception of the carboniferous ferns, so many examples of fern-like plants being now known to have borne seeds or being suspected of having been seed-bearers, that comparatively few undoubted ferns were left, and it was questioned whether, at least, in the Lower Carboniferous true ferns existed. One family, the Botryopterideæ, was admitted to be well represented in Lower as well as Upper Carboniferous times, and Mr. Newell Arbor has proposed to establish a group of Primofilices to include this and other primitive ferns of the Palæozoic age. The object of the communication was to give a few illustrations of the ancient race of ferns. The Botryopterideæ were first described, beginning with the type genus *Botryopteris*. The genus *Zygopteris* was next considered, and a new genus from the Lower Coal Measures of Lancashire, for which the name of *Botrychioxyton* was proposed. Two or three other examples of the family having been noticed, Dr. Scott described certain annulate fern sporangia. The germination of spores within a sporangium was demonstrated, and this sporangium had quite recently been identified as belonging to *Stauropteris oldhamia*. The paper was illustrated by fossil and recent sections thrown on the screen, and by lantern slides.

Quekett Microscopical Club.

June 15. Mr. A. E. Hilton read a paper "On the Study of the *Mycetozoa*." Having referred to the still existing uncertainty as to the correct classification, the lecturer dealt with the distribution and general habitats of the group. The life-cycle in brief is: The spores, usually about 10 μ in diameter, rupture when immersed in water, and jelly-specks, each with a nucleus and two or three vacuoles, are liberated. These are the swarm-cells. They assume first an amœboid form, and subsequently resemble flagellate infusoria. After multiplication by encystment and division, they coalesce into a larger mass, the plasmodium; this, after slowly creeping about after food on decaying vegetable substances, ultimately comes to rest and throws up sporangia, which vary from $\frac{1}{80}$ to $\frac{1}{5}$ of an inch in height. The sporangia scatter spores and a new life-cycle begins. These various stages were described at length with reference to a series of coloured drawings of *Comatricha obtusata*, one of the commoner forms. Members yet undicided as to what line of research to follow were strongly urged to take up the study of this group. Its simplicity, especially when compared with botany or entomology, was pointed out, and books were named, dealing with the subject, and hints on the collection and cultivation of specimens were given at length. Mr. Hilton exhibited a large number of specimens of *Mycetozoa*, under microscopes, and Mr. J. Burton showed some active swarm-cells of *Brefeldia maxima*.

New Object Finder.

Messrs. R. and J. Beck, Ltd., have sent me for inspection a new finder, by Mr. J. M. Coon, which was recently exhibited at a meeting of the Royal Microscopical Society, and which is designed for use on the ordinary plain stage of any microscope. There is a special label for attachment to the microscope slip, and a pointer with universal movements and clamps for attachment to the microscope stage. This pointer has two points, as illustrated herewith. The label will be seen to be ruled in squares, numbered horizontally and lettered vertically for convenience of reference, and sub-divided into sixteen equal triangles for further refinement if necessary. In addition, two "focussing marks," or adjustment marks, are provided. The label being affixed to the right of a slide in the usual way, the objective is focussed on the left-hand mark. The pointer is clamped upon the stage, and so adjusted that



the main point lies upon the right-hand mark, and the other point is on the straight line upon the end of which this setting mark is situated. It is obvious that when the slide is now moved bodily to the right so as to bring the object itself into the field of view of the microscope, the pointer (which has not been moved) will, if an ordinary 3 by 1 inch slide is used, come to point over some of the intersecting lines of the label. These are noted, and either the letters and numbers are taken, or two ink-spots are made as a register. To find an object, it is therefore only necessary to repeat the process and to again move the slide until the pointer stands over the register marks. A microscopist can thus not only register a slide for use even with high powers, but can send it to another observer with instructions that will enable him to examine any portions so registered. The price of the finder, with labels, is half-a-guinea.

Stain for Photo-Micrography.

A note in the current issue of the Journal of the Royal Microscopical Society, gives the following stain as being recommended by Mr. E. Moffatt, for photo-micrography:—Fuchsin, .06 grm.; methylen-blue, .04 grm.; alcohol (90 per cent.), 5 c.cm. Add aqueous solution of carbolic acid, 5 per cent. to make up to 25 c.cm. Make films from cultures, in the usual way, and flood with the filtered stain; warm gently, wash well, dry in air, and mount in balsam. This solution is a very powerful stain, and used as above, gives excellent results with diphtheria, anthrax, cocci, and other

bacteria, rendering these organisms very easy to photograph when the film is prepared from a pure culture. The solution, when diluted, is serviceable for section staining.

Acetone-celloidin Method of Rapid Embedding.

F. Scholz places pieces of material not thicker than 3 mm. in pure acetone for half an hour. They may then be transferred to celloidin, though it may be necessary to pass certain material through alcohol-ether for 15 minutes. The pieces remain in a thin celloidin solution for 4 to 5 hours, at 37° to 40°. They are then transferred to a thicker solution for 2 to 3 hours, after which they are placed in thick celloidin. In the last condition they are submitted to the action of chloroform vapour, in a closed vessel. In about 14 hours they will be of the consistence of cartilage. The blocks are next further hardened in alcohol for some hours.

Origin of Parasitism in Fungi.

Mr. George Massee, in a paper read before the Royal Society, concludes with three interesting statements as to the origin of parasitism in fungi: (1) The entrance of the germ tubes of a parasitic fungus into the tissues of a living healthy plant depends on the pressure of some substance, in the cells of the host, attractive to the fungus. In other words, infection is due to positive chemotaxis. (2) A saprophytic fungus can be gradually educated to become an active parasite on a given host-plant, by means of introducing a substance positively chemotactic to the fungus, into the tissues of the host. By similar means a parasitic fungus can be induced to become parasitic on a new host. (3) An immune plant signifies an individual of the same species as the one on which a given species of fungus is parasitic, but which, owing to the absence of the chemotactic substance in its tissues necessary to enable the germ-tubes of the fungus to penetrate, remains unattacked. The author made a series of experiments to verify these statements, using the expressed juice of leaves as culture solutions, and testing the presence of the chemotactic substance by sowing fungus spores on a mica film, in which a hole had been bored, and placing it in contact with the juice. If the chemotactic substance were there, the germinating tube of the spore grew towards the hole. He also found that the chemotactic property could be destroyed by the addition of certain reagents, such as a trace of acetic acid, etc. In order to educate a plant to become host to any parasite, he injected into the tissues some substance chemotactic to the fungus. Thus he induced *Penicillium* to invade the leaves of *Tradescantia discolor*, by injecting into it a solution of cane-sugar. Other saprophytic species were induced to become parasites on *Begonia* leaves by the same method, and after fifteen generations they grew as parasites without any addition of a sugar solution.

Cheap Glass Lenses.

A German publication mentions a cheap and simple way of obtaining large lenses for photographic and similar work, by forming a combination of ordinary watch or clock glasses with water or other suitable liquid. Two glasses, whose edges must be well ground so as to fit closely when in contact, are dipped into the liquid, and removed bodily filled with it. The edges are then wiped dry, and moistened with water-glass, which, helped with a little hydrochloric acid, sets quite hard, so that the "lens" can be freely handled. This process is assisted by the use of a peculiar brush, having two pencils on one shaft. As this brush is passed round the periphery, the front pencil wipes off the superfluous fluid, and the following pencil applies the water-glass. By means of a glass disc and a watch glass, a plano-convex lens can be made, and several other forms are possible.

New Triple Stain for Cytology.

Dr. Victor Bonney has devised a modification of Flemming's "Triple Stain," for cytological and histological purposes, which gives a sharp differentiation between the various constituents of the nucleus, cytoplasm, and inter-cellular tissues, and is at the same time simple, rapid, and reliable. The object of Flemming's original method was to combine in the tissues the stains saffranin, gentian-violet, and orange G, so that the chromatin substance of the nucleus should be stained by the gentian-violet, the cytoplasm by saffranin, and the inter-cellular substances by the orange. The method has, however, fallen into some disrepute on account of its uncertainty. Dr. Bonney's modification is as follows: (1) Fix small pieces of the tissue in acetic alcohol for five to fifteen minutes, according to size (*pure* glacial acetic acid one part, and *absolute* alcohol two parts). Dehydrate rapidly in several changes of absolute alcohol. (2) Embed, cut, and mount in the usual manner. (3) Stain for one hour in a saturated watery solution of saffranin. (4) Wash in water. (5) Stain for a quarter of an hour in a saturated solution of methyl-violet. (6) Wash in water, *and wipe the slide dry, except that part occupied by the section.* (7) Have ready in a drop-bottle the following solution: To 20 c.c. of acetone add, *drop by drop*, a saturated watery solution of orange G, until the flocculent precipitate, which slowly appears on shaking, is just dissolved in excess of the watery solution; then filter. (8) Flood the slide with this solution. A cloud of colour immediately comes out, which obscures the view of the section. (9) Pour this off on to blotting-paper and flood again with the same solution. The colour cloud being much fainter, the section can be watched. (10) When the section has attained a *rather faint* brownish-pink colour, pour off the orange-acetone solution. (11) Wash in acetone for a few seconds. (This should be contained in a small glass jar, acetone being very volatile; care should be taken that the section does not dry.) (12) Wash in xylol. (13) Transfer to low-power microscope and see if the proper result has been attained. (14) Wash in two fresh changes of xylol. (15) Mount in xylol-balsam.

All chromatic elements, nucleoli, and certain nuclei, such as those of polymorphonuclear leucocytes, stain a rich violet, chromosomes standing out with peculiar distinctness. The spindle fibres of nuclear mitosis stain a faint pink. The cytoplasm stains a rose pink. The inter-cellular tissue stains a pale yellow. These effects are best seen if the slide be examined through a deep blue screen. The most important factor in the process is the orange-acetone solution. If this is allowed to act too long, the whole section is stained a deep yellow, while if it has not acted long enough the section is blotchy and has a distinct violet tint. If the colours are discharged too rapidly, the orange-acetone must be diluted with acetone. The reagent deteriorates after a time.

[*Communications and Enquiries on Microscopical matters should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge.*]

The Face of the Sky for August.

By W. SHACKLETON, F.R.A S.

THE SUN.—On the 1st the Sun rises at 4.23 and sets at 7.48; on the 31st he rises at 5.11 and sets at 6.49.

There is a partial eclipse of the Sun on the 19th, but no part is visible in this country; it is only visible from the Arctic regions and West of Canada. The magnitude of the eclipse is 0·315 (Sun's diameter = 1).

Sunspots, after a period of sparseness, are again fairly numerous; at the time of writing several conspicuous groups are visible on the solar disc.

The positions of the Sun's axis, centre of the disc, and heliographic longitude of the centre are given in the following table:—

Date.	Axis inclined from N. point.	Centre N. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
Aug. 4 ..	12° 0′ E	6° 5′	316° 48′
,, 9 ..	13° 55′ E	6° 24′	250° 43′
,, 14 ..	15° 42′ E	6° 40′	184° 36′
,, 19 ..	17° 24′ E	6° 53′	118° 31′
,, 24 ..	18° 58′ E	7° 3′	52° 28′
,, 29 ..	20° 23′ E	7° 10′	346° 24′

THE MOON:—

Date.	Phases.	H. M.
Aug. 4 ..	○ Full Moon	1 0 p.m.
,, 12 ..	☾ Last Quarter	2 48 a.m.
,, 20 ..	● New Moon	1 28 a.m.
,, 27 ..	☽ First Quarter	0 43 a.m.
,, 1 ..	Perigee	6 48 a.m.
,, 13 ..	Apogee	5 48 a.m.
,, 27 ..	Perigee	9 30 a.m.

There is a total eclipse of the Moon on the morning of the 4th. It is invisible in this country, but visible over part of North America and the greater part of the Pacific Ocean.

OCCULTATIONS.—The following are the particulars of the occultations visible from Greenwich before midnight:—

Date.	Star's Name.	Magnitude.	Disappearance.		Reappearance.	
			Mean Time.	Angle from N. point.	Mean Time.	Angle from N. point.
			h. m.		h. m.	
Aug. 4	ι Capricorni ..	4·3	9 3	78°	10 13	260°
,, 5	45 Aquarii ..	6·3	9 40	76°	10 50	252°
,, 29	ξ^2 Sagittarii ..	3·5	6 29	88°	7 43	276°
,, 31	19 Capricorni ..	6·0	6 10	17°	6 36	330°

THE PLANETS.—Mercury (Aug. 1, R.A. 9^h 46^m; Dec. N. 9° 3′. Aug. 31, R.A. 9^h 26^m; Dec. N. 15° 12′) is in inferior conjunction with the Sun on the 12th, and hence is invisible during the former part of the month; towards the end of the month the planet is a morning star in Leo, and attains a greatest westerly elongation of 18° 11′ on the 29th. This is a favourable elongation, the planet rising at 3.26 a.m.

Venus (Aug. 1, R.A. 11^h 21^m; Dec. N. 5° 5′; Aug. 31, R.A. 13^h 21^m; Dec. S. 9° 59′) is an evening star in Virgo, and may be observed in the evening sky looking W. immediately after sunset. As seen in the telescope the planet appears gibbous, 0·65 of the disc being illuminated.

On the evening of the 7th the planet will appear in conjunction with the star β Virginis, as shown in the

diagram, the separation being only 15′ at 1 p.m. On this date the planet sets at 9 p.m.

Mars (Aug. 1, R.A. 8^h 23^m; Dec. N. 20° 31′; Aug. 31, R.A. 9^h 40^m; Dec. N. 15° 10′) is a morning star, rising about 3.45 a.m. throughout the month.

Jupiter (Aug. 1, R.A. 6^h 1^m; Dec. N. 23° 8′; Aug. 31, R.A. 6^h 25^m; Dec. N. 23° 2′) rises about 1 a.m. on the 1st of the month, and about 11.30 p.m. on the 31st. The planet is situated near the star 1 Geminorum.

Saturn (Aug. 1, R.A. 23^h 4^m; Dec. S. 8° 9′; Aug. 31, R.A. 22^h 57^m; Dec. S. 9° 0′) is an evening star describing a retrograde path in Aquarius. Near the middle of the month the planet rises about 8 p.m., and is on the meridian at 1.30 a.m. We are looking on the northern surface of the ring, the outer major and minor axes of which are 44″ and 3″ respectively, whilst the apparent semi-diameter of the ball is 8″·8.

Uranus (Aug. 15, R.A. 18^h 21^m; Dec. S. 23° 41′), though somewhat low down in the sky, is well placed for observation during the early evening, the planet being due south on the 15th at 8.48 p.m. He is situated a little to the S.E. of the star μ Sagittarii. Uranus is just perceptible to the naked eye, but can easily be seen with a pair of opera glasses. The diameter of the disc is nearly 4″, and the colour is greenish. As seen in large telescopes the planet appears more luminous at the centre of the disc than at the limb—somewhat similar to Jupiter and Saturn.

Neptune (Aug. 15, R.A. 6^h 50^m; Dec. N. 22° 4′) does not rise until after midnight. He is situated about 1° north of the star ζ Geminorum.

METEORS:—

Date.	Radiant.		——
	α	δ	
Aug 10-12	45°	+ 57°	Great *Perseid* shower; radiant moving E.N.E. about 1° per day.
Aug. 21-25	291°	+ 60°	o Draconids; bright slow meteors.

Minima of Algol occur on the 19th, at 0.16 a.m., and on the 21st, at 9.5 p.m.

Mira (ο Ceti) is due at minimum on the 15th, but frequently the phases are retarded; the star varies from magnitude 3·3 to 8·5.

TELESCOPIC OBJECTS:—

Double stars: Polaris, mags. 2·1, 9·5; separation 18″·6. The visibility of the fainter star is frequently used as a test for a good 2-inch object glass.

ζ Sagittæ, XIX.^{h} 45^m, N 18° 53′, mags. 5, 10; separation, 8″·6.

α^1 α^2 Capricorni XX^h 12^m, S. 12° 15′, mags. α^1 4·5, α^2 3·8; naked eye double, separation 373″, very easy with opera glasses.